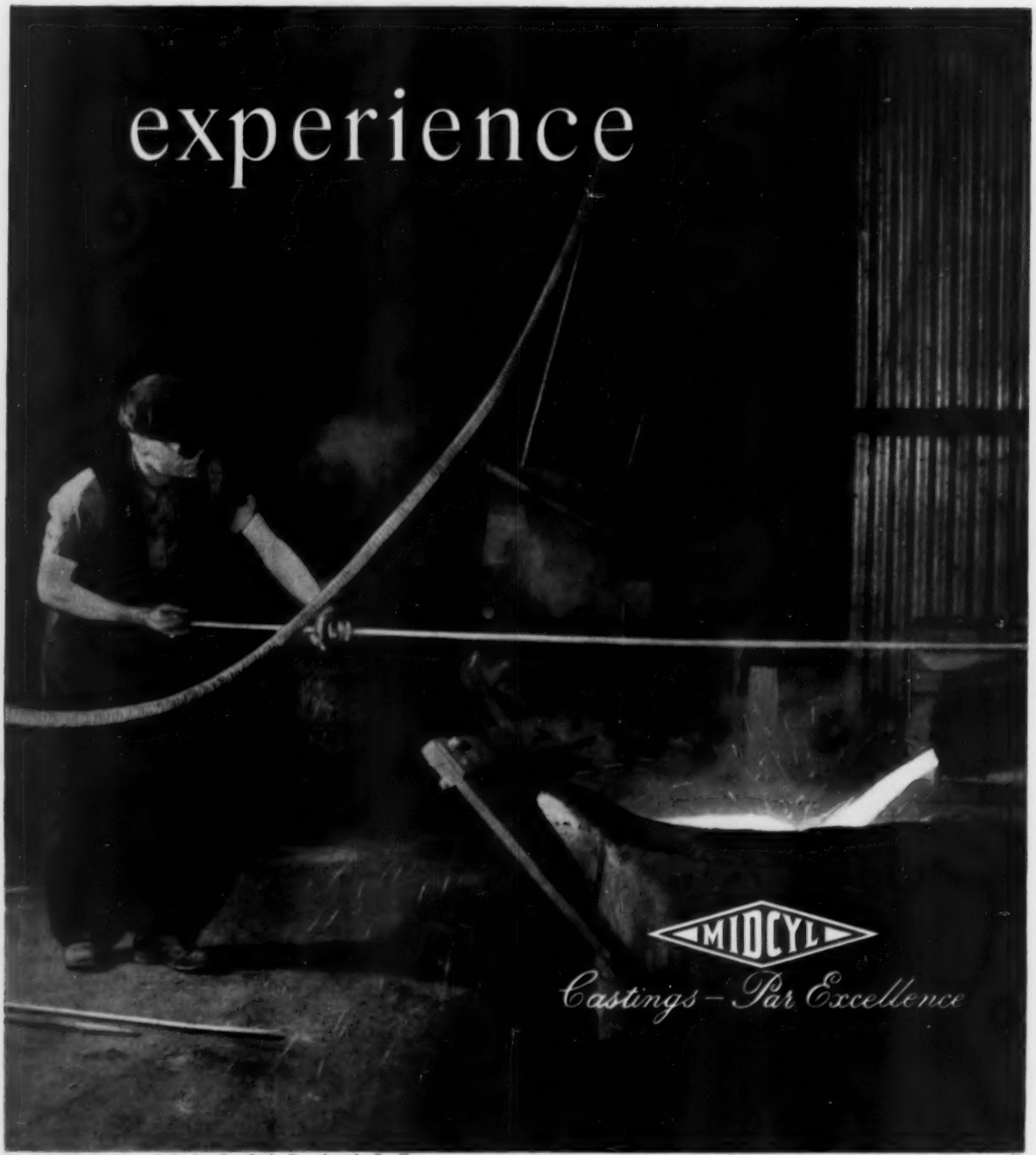
AUTOMOBILE ENGINEER

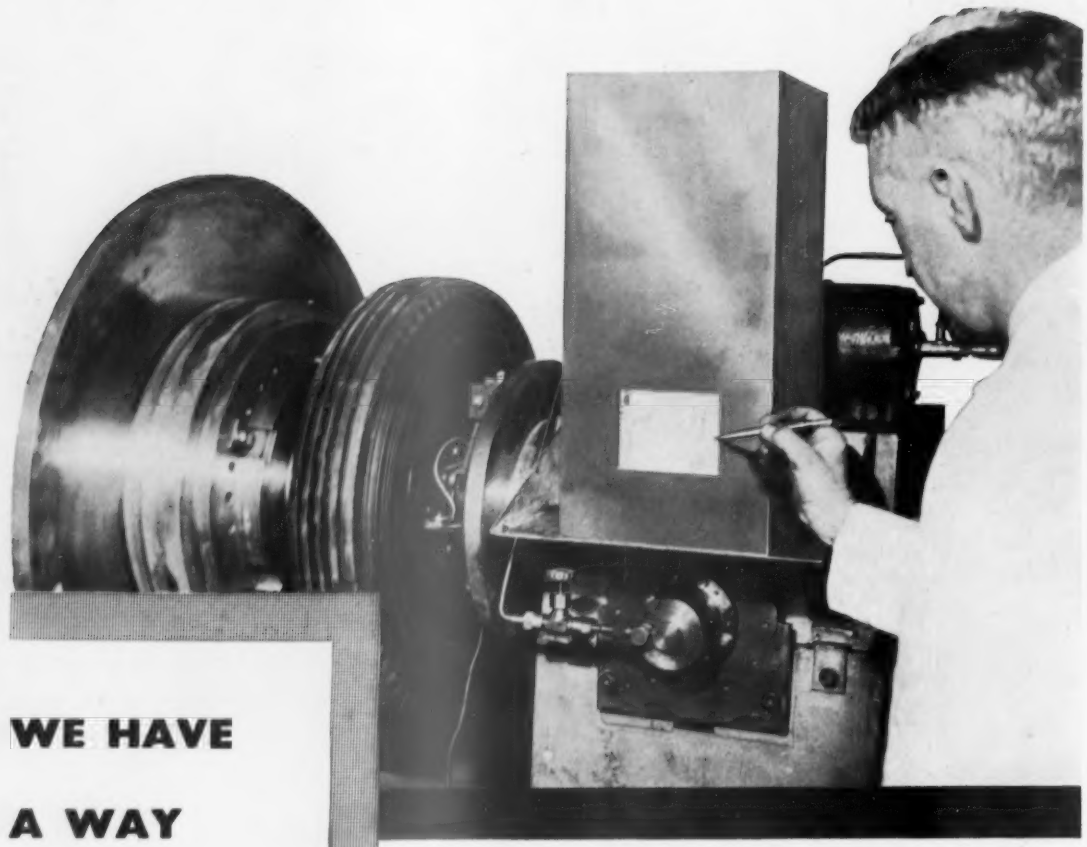
DESIGN · PRODUCTION · MATERIALS

Vol. 45 No. 11 NOVEMBER 1955 PRICE: 3s. 6d



The Midland Motor Cylinder Co. Ltd., Smethwick, Staffs.

M-W.68



WE HAVE A WAY WITH BRAKES

Into our Research Department at Cleckheaton come all manner of problems to do with brakes. Here we can reproduce the actual service conditions under which brakes operate and check performance on machines and delicate instruments which leave no room for guesswork.

The work goes on unceasingly . . . much of it devoted to anticipating the problems of the future. Mintex leadership is based securely on the work done in our laboratories and research departments.

When high performance counts

you can rely on MINTEX

MINTEX BRAKE AND CLUTCH LINERS ARE MANUFACTURED BY BRITISH BELTING & ASBESTOS LIMITED, CLECKHEATON, YORKSHIRE

3 HANDY POCKET-SIZE BOOKS

that will help you to get the best out of CARBIDE TOOLING

These three books are packed full of useful information on all aspects of carbide tooling:—

APPLYING WIMET deals with the basic principles of carbide tool design—choice of angles—use of chip breakers, tool setting, etc.

RESERVICING WIMET discusses the simple technique necessary for efficient reservicing—selection of grinding and lapping wheels, etc.

WIMET AT WORK gives full details of a number of examples showing the current diverse nature of Wimet applications in a variety of industries.

Write to:—
The Publicity Dept., Wickman Ltd., Coventry, and ask for these helpful books.

WICKMAN LIMITED

WIMET DIVISION, TORRINGTON AVENUE, COVENTRY

Telephone: Tile Hill 66621

3095T

A leap in the dark!

"TIS THE ROUNDHEADS, Sir Percy. Haste thee, Milord — jump for it!"

"But 'tis dark outside," said Sir Percy plaintively — off the battlefield he was a man of cautious disposition — "'tis wondering where to jump I am?"

"'Tis no time to ponder" retorted the Squire, "Haste!"

"Very well then, I suppose thou knowest best." Sir Percy grasped his sword, swung his cloak, and leapt into a world of darkness; he was pleasantly surprised to land on something soft and yielding. "Gad!" he beamed, "the age of miracles is not yet past." From beneath him, oddly muffled, the Squire's voice choked; "'Twould be uncommon kind of milord to remove his scabbard from the small of my back."

"Faith!" cried the cavalier — "here is a waggish situation indeed. Mesceems I made a splendid landing on thy broad and faithful back. And where didst *thou* come to earth, old friend?"

The Squire squirmed uneasily. "Verily I could not swear to it, but if I mistake me not, we are in the cattleyard." His movements were accompanied by an odd squelching sound. "Verily thou wert unfortunate," said Sir Percy with soldierly sympathy — "perhaps that will teach thee the folly of a spring in the dark. And speaking of springs" — he spake with a knowledge surprising in one of that period — "Didst know that the most inferior springs may look exactly like a genuine high precision job, guaranteed for years of high performance? What! not interested in springs? Ah, well, perhaps a tub would suit thee better." He ambled off into the darkness . . .

Advertiser's Announcement

Don't take unnecessary risks...

SPECIFY SPRINGS BY

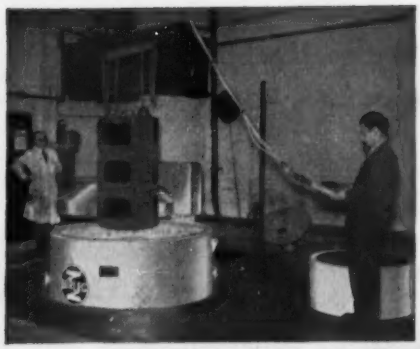
SALTER

Famous for Springs since 1760

TO BE SURE!

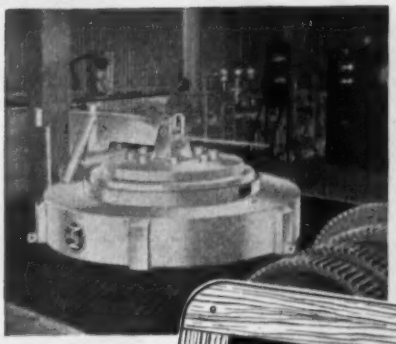
GEO. SALTER & CO. LTD., WEST BROMWICH

M-W-416



GAS CARBURISING

...that's correct



top: two 100 kW units, 27″ diam. x 54″, for heavy gear parts.

centre left: gas fired unit, 48″ diameter x 48″ deep, using endothermic atmosphere generator.

centre right: the smallest standard pit unit; 40 kW furnace with drip-feed carburising system.

bottom: two 65 kW furnaces, 24″ diameter x 42″ deep, with (rear) pit tempering furnace and (front) the gas atmosphere generator.

Birlec Publication No. 70 gives full details; it will gladly be sent.

- ✓ Gas Carburising is now accepted as the most economical - and most efficient - means of imparting controlled hardened case depths to engine, transmission, machine tool and other components.
- ✓ Birlec Limited has over 70 standard pit gas carburising furnaces in commission, providing comprehensive experience on atmosphere control, loading and charge handling techniques and time/temperature cycles.
- ✓ Both electric and gas-heated designs are available.
- ✓ Atmosphere production is either by enriching carrier gas, provided by an endothermic generator, or by the liquid "drip-feed" process.
- ✓ Standard charge space dimensions vary upwards from 18″ diameter X 30″ deep to 48″ diameter X 48″ deep.

BIRLEC

BIRLEC LIMITED

Member of the A.E.I. Group of Companies

ERDINGTON · BIRMINGHAM 24

Also LONDON · SHEFFIELD · GLASGOW · NEWCASTLE-ON-TYNE

SM/B2462/55

FOR HEAVY DUTY DIE AND TOOL WORK

34" Archdale

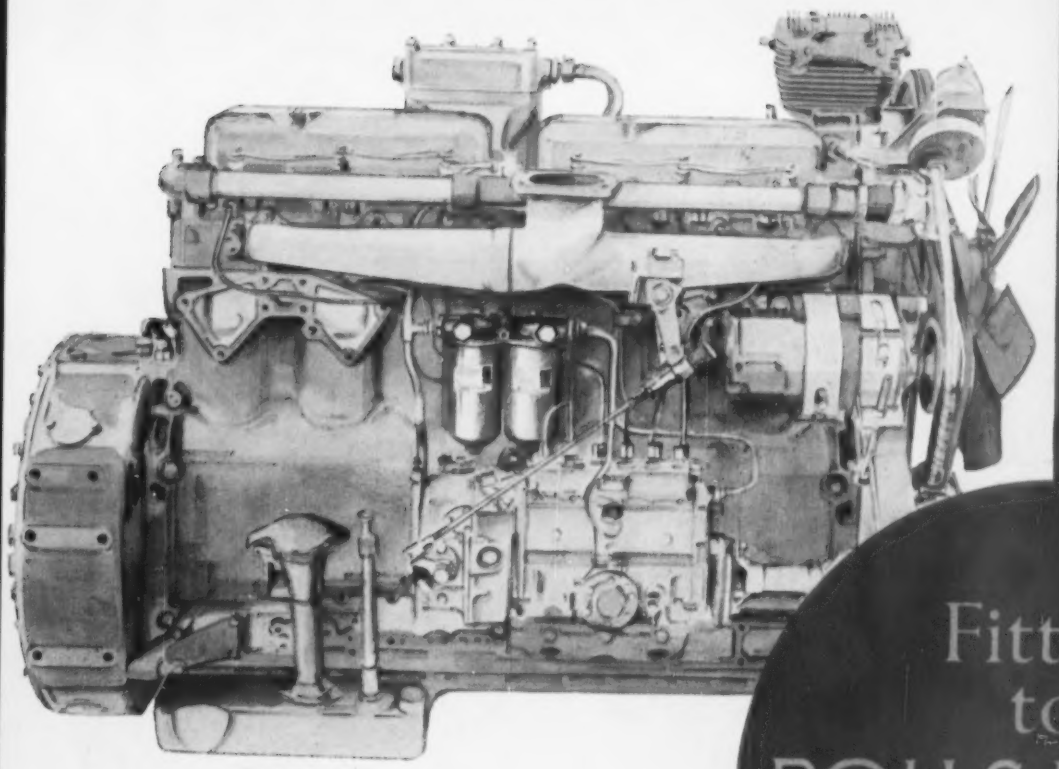
VERTICAL MILLING MACHINE

with combined sliding and swivelling head . . . .

This massive, powerful and versatile machine, with its sliding and swivelling head, makes light of heavy duty die and tool work at The Enfield Cycle Co. Ltd., Redditch. Table has reversible automatic feeds and quick-power traverse in all three directions. Speeds and feeds changed from front of machine. Direct reading dials. Twelve speeds from 29/520 r.p.m., or alternatively 36/638 r.p.m. Twelve feeds, ¾ in. to 20 in. per minute. Quick and fine hand adjustment to spindle, which swivels through 90°. Table working surface 53 in. × 14½ in.

JAMES ARCHDALE & CO. LTD · BIRMINGHAM · 16

SOLE SELLING AGENTS: ALFRED HERBERT LTD., COVENTRY



Fitted to ROLLS-ROYCE oil engines

For diesel fuel

Purolator 'Micronic' filters are being used to a rapidly increasing extent for filtering diesel engine fuel.

With its unique, specially-impregnated paper filter element, the Purolator 'Micronic' filter has three great advantages:

1. *The filter element is not damaged by diesel fuel.*
2. *It is completely water-resistant.*
3. *It has a very long life.*

There is a Purolator filter for every purpose, lubricating oil, fuel oil, petrol—even for water.

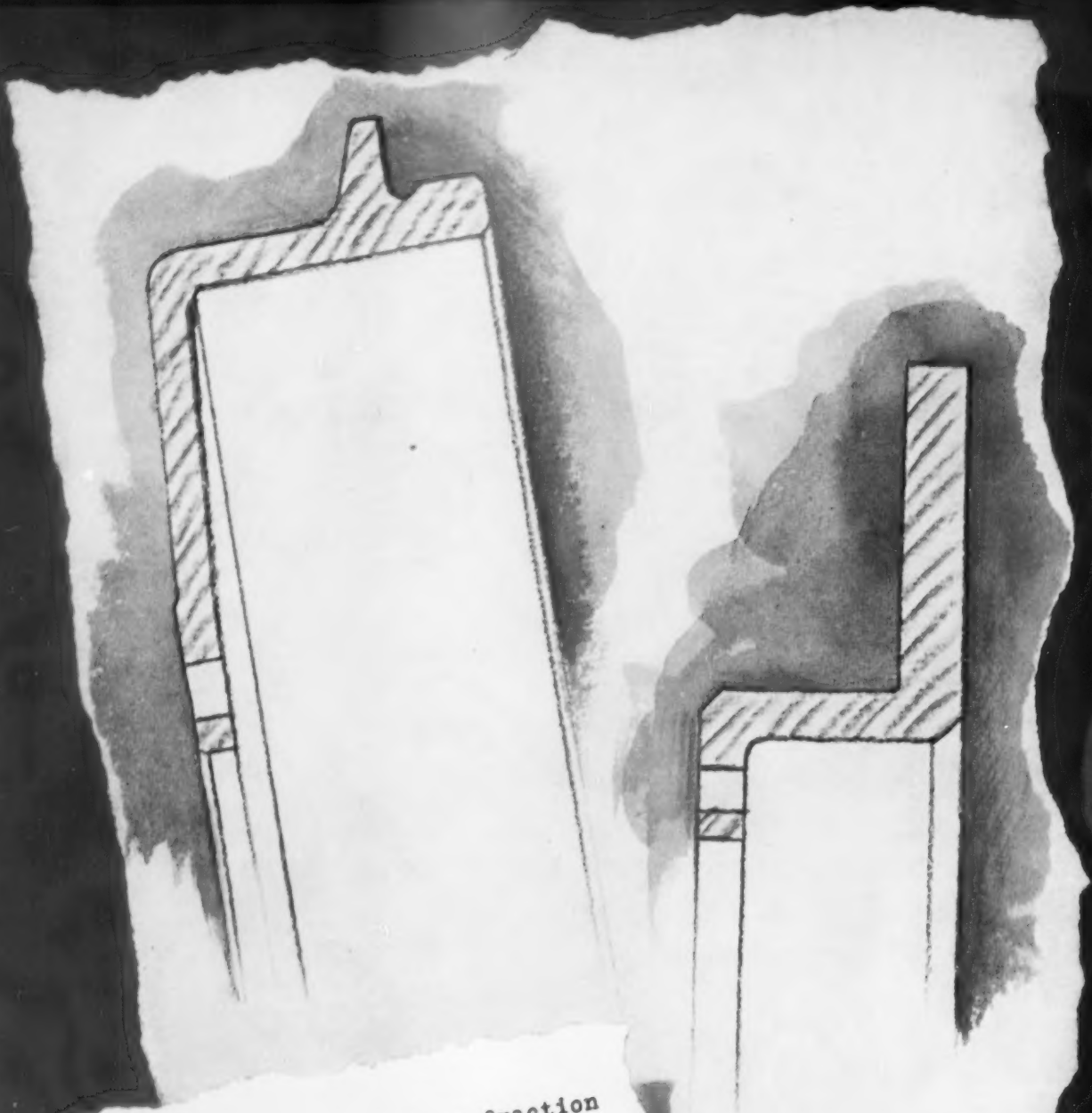
The illustration shows the Rolls-Royce 6-cylinder model C6.SFL. Series 109 supercharged engine, rated at 250 b.h.p. at 2100 r.p.m., fitted with Purolator fuel-oil filters.

PUROLATOR

MICRONIC FILTER

Registered Trade Marks: 'Purolator', 'Micronic'
AUTOMOTIVE PRODUCTS COMPANY LTD., LEAMINGTON SPA, ENGLAND

AUTOMOBILE COMPONENTS



In the disc brake only a fraction of the surface area is being heated - all the rest is being cooled. Moreover, it is the actual braking surface itself that is cooled, without reliance upon conduction through the thickness of the metal.

Drum versus Disc

A great deal has been said, possibly too much at too early a date, about the disc brake and its advantages.

The disc brake—like the toothless friction saw employed to cut off steel joists—owes its success to the fact that most of the disc's surface is being cooled by the air, while only a small arc of the disc is being heated by contact with the brake pad.

This distinction is well-known but it is not so widely realized that, if we compare a drum brake of normal car type with a disc brake built into about the same space, the metal braking surface of the disc, counting both sides, is considerably greater than that of the drum. In other words, the heat to be handled per square inch of drum is less with the disc brake.

But it is also fundamental that the braking material is likewise only spread over a small arc. True, it is constantly engaging, at any rate on its leading edge, a disc surface which has been somewhat cooled, whereas in the conventional drum brake the arcs engaged by the lining (the heating arcs) are greater, and the rest of the drum (the cooling arcs) is less, and of course, far less effectively cooled.

It is self-evident that the exposed cooling arc of the disc brake, in direct contact with the air, is the actual braking surface itself, whereas the brake drum on the conventional car depends for its cooling chiefly on the outer surface, the heat having to pass through the wall of the drum. This can give a very undesirable temperature gradient and, with the absence of a considerable mass of turbulent air moving over the braking surface, very high temperatures indeed are attained within the drum.

The dividing line of severity of duty at which one should choose the disc brake in preference to the drum brake cannot be easily drawn.

Drum brakes for the great majority of cars on the road give satisfaction, and they have a great number of advantages, including their simplicity, a neat 'home' all ready to take them, their easy enclosure, and their general understandability, which suit them particularly well to the car of ordinary performance, even though that ordinary performance is constantly tending in the direction of the extraordinary.

It is perhaps possible to divide the reasons for choosing the one or the other into two different categories.

The first reason, of course, is the one which has caused the disc brake to come into being, that is, the need for a brake which will stand up to those extraordinary demands of racing and other high speed braking which cannot be met by ordinary drum types of brakes conventionally located.

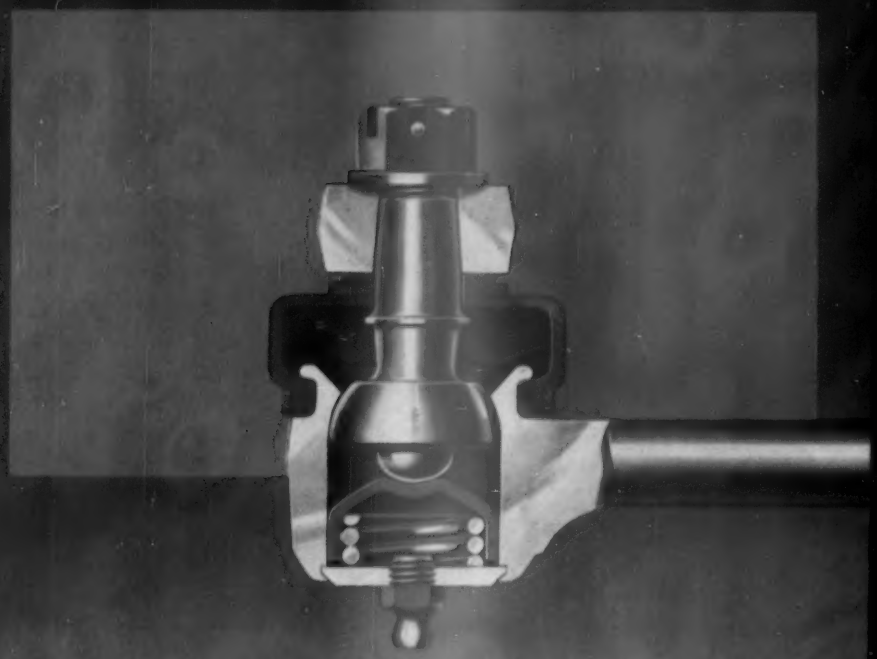
The other reason for choosing one or the other is concerned with the sacrifice (in cost, durability and so on) that the user is prepared to pay for performance.

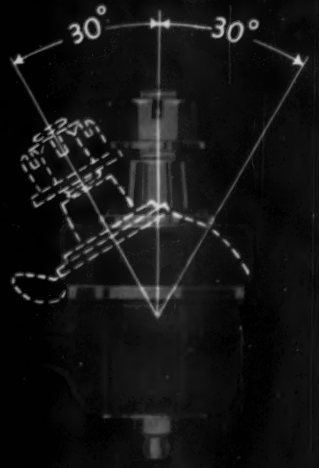
In some cars which have come under consideration, the best arrangement seems to be the use of drum brakes on the rear wheels, and disc brakes on the front wheels, which take the lion's share of the braking.

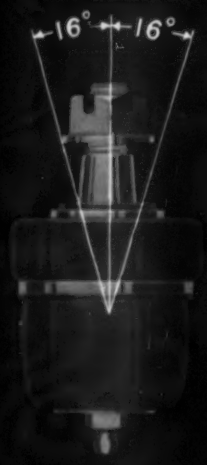
LOCKHEED

AUTOMOTIVE PRODUCTS COMPANY LIMITED, LEAMINGTON SPA, ENGLAND
Regd. Trade Mark: Lockheed

THE DUAL TYPE
HIGH ANGLE SIDE-ROD







The illustration shows a size 'A' dual-type ball joint and fixed one-piece side rod. This is used in conjunction with an adjustable centre rod. This three-rod system is used extensively on popular British small and medium-sized cars of modern design.

The adjustable centre rod has left-hand and right-hand threading to the ball joint assemblies, thus providing a simple adjustment which is effected by unlocking the locknuts on the ball joint assemblies and turning the intermediate bar to correct toe in or toe out.

In addition to the 'A' size, which is suitable for front axle laden weight of approximately 11¼ cwt., there are two sizes; 'B', suitable for front axle laden weight of approximately 11¼ to 16 cwt., and size 'C', suitable for front axle laden weight of approximately 16 to 21 cwt.

A feature of these steering joints is the greater angular movement between the ball pin and rod which allows for excessive movement of the axle over rough ground.

Particular attention has been paid to the exclusion of dirt and water by the provision of a boot which is positively sealed.

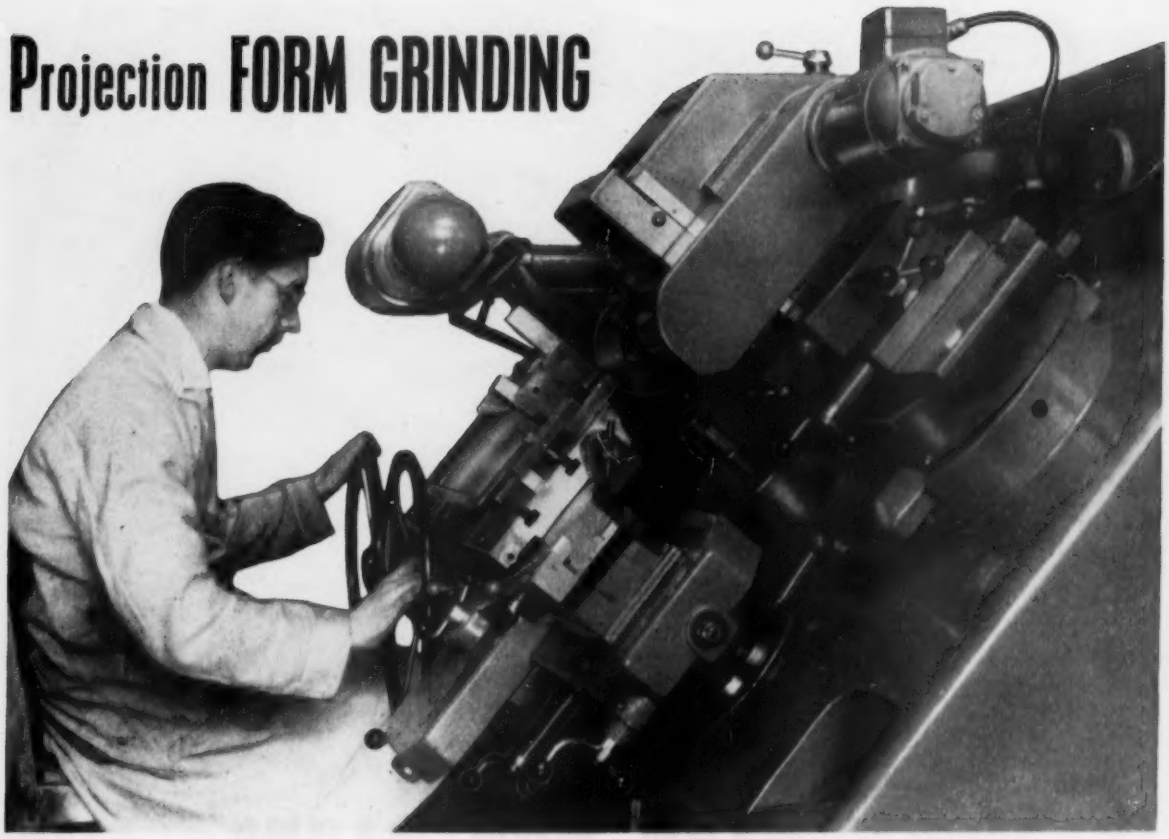
Thompson

Self-adjusting

STEERING ROD ASSEMBLY

AUTOMOTIVE PRODUCTS COMPANY LIMITED,
LEAMINGTON SPA, ENGLAND

Projection FORM GRINDING

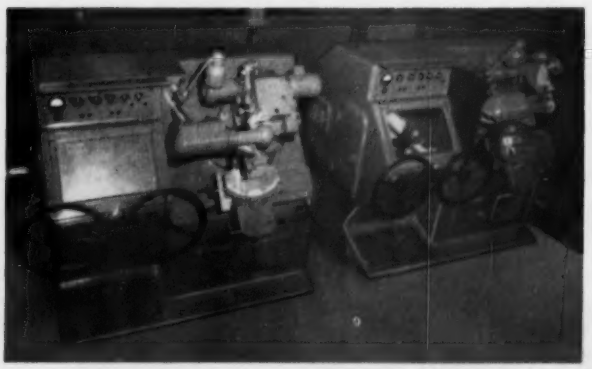


as simple as driving a car!

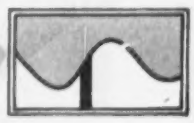
Engineers with a high reputation to uphold appreciate the speed and simplicity with which accurate forms in tungsten carbide and hardened steel can be produced on the PeTeWe Form Grinder. These illustrations show three machines installed at Alfred Herbert Ltd., Coventry, and here's their comment.

"These machines outdate all other methods of Form Grinding."

It will pay you to investigate further—write today for a catalogue.



the drawing
the workpiece
the wheel



are all on the same screen on the PeTeWe

Sales and Service for . . . **DRUMMOND-ASQUITH** *. . . the British Isles*

IMPORT/EXPORT DIVISION: HALIFAX HOUSE, STRAND, LONDON, W.C.2

'Phone: Trafalgar 7224-6

TURN BACK THE PAGES...

One of the most famous cars in the world—the well-loved 'Baby' Austin of the nineteen twenties.

Hardy Spicer first supplied 'Hardy' flexible couplings for the Austin seven in 1922.

Today AUSTINS, in common with the majority of modern motor manufacturers, fit Hardy Spicer propeller shafts and couplings to its successor the present day A.30, and their entire range of passenger cars and commercial vehicles.

HARDY SPICER

HARDY SPICER LTD · BIRCH ROAD · WITTON · BIRMINGHAM 6

(A Birfield Company)

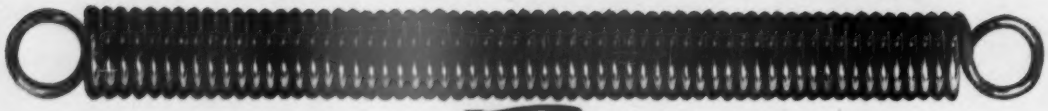
In the motor car industry you'll find Meadowfelt working for its living.

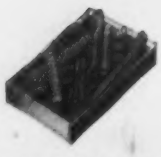
Meadowfelt is at work in factories all over the country, as filters, seals, gaskets, washers, joints, shock-absorbing mountings —and in a hundred and one other applications.
Meadowfelt can be made to your precise specifications; it can be made as hard as a board or as light as thistledown; it can be die-cut or punched; it is invaluable in packaging.
Make Meadowfelt work in your industry. You'll find it pays.

Meadowfelt

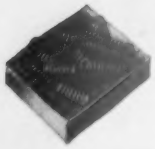
**versatile . . .
hard-working . . .
economical**

Order from Kidderminster. THE LONG MEADOW FELT CO., KIDDERMINSTER. THE FELT DIVISION OF CARPET TRADES LTD.

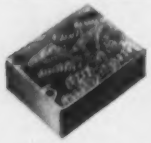




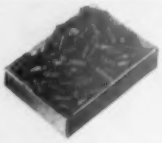
No. 760. 3 doz. Assorted Light Compression Springs 1" to 4" long, 22 to 18 S.W.G., ¼" to ½" diam. 6/6 each.



No. 98A. 3 doz. Assorted 1" to 4" long, ¼" to ½" diam., 19G to 15G. 5/6 each.

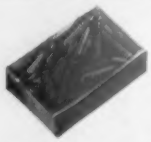


No. 757. Extra Light Compression, 1 gross assorted, ¼" to ½", ¼" to 2" long, 27 to 20 S.W.G. 15/- each.

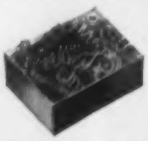


No. 388. ¼ gross Assorted Small Expansion Springs. ½" to 1¼", 18G to 21G. 9/6 each.

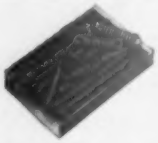
No. 758. Fine Expansion Springs. 1 gross Assorted ½" to ¼", ½" to 2" long, 27 to 20 S.W.G. 15/- each.



No. 466. ¼ gross Assorted Small Expansion Springs ½" to 1¼" long, 3/32" to 3/16" diam., 21G to 24G. 6/6 each.



No. 1024. 20 Compression Springs 12" long. ½" to ½" diam. 24G to 18G, suitable for cutting into shorter lengths; and 30 Expansions 1¼" to 12" long, 5/32" to ½" diam., 22G to 16G. 24/- each.



No. 753. 3 doz. Assorted Light Expansion ½" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. 10/6 each.

No. 1013. 1 gross Small Coil Compression Springs, ½" to 1¼" long, 3/32" to ⅜" diam., 24G to 19G. 6/- each.

How are you off for Springs?

TERRY'S BOXES OF ASSORTED SPRINGS are just the job for your experimental department—a wonderful assortment of Compression and Expansion Springs . . . all sorts of lengths, gauges, diameters. The nine boxes we show are just a few from our range. Why not let us send you a full list—free?

TERRY'S ASSORTED SPRINGS

The prices quoted are subject to the usual trade discount.

HERBERT TERRY & SONS LTD. REDDITCH, WORCS · SPRING MAKERS FOR 100 YEARS

HT17

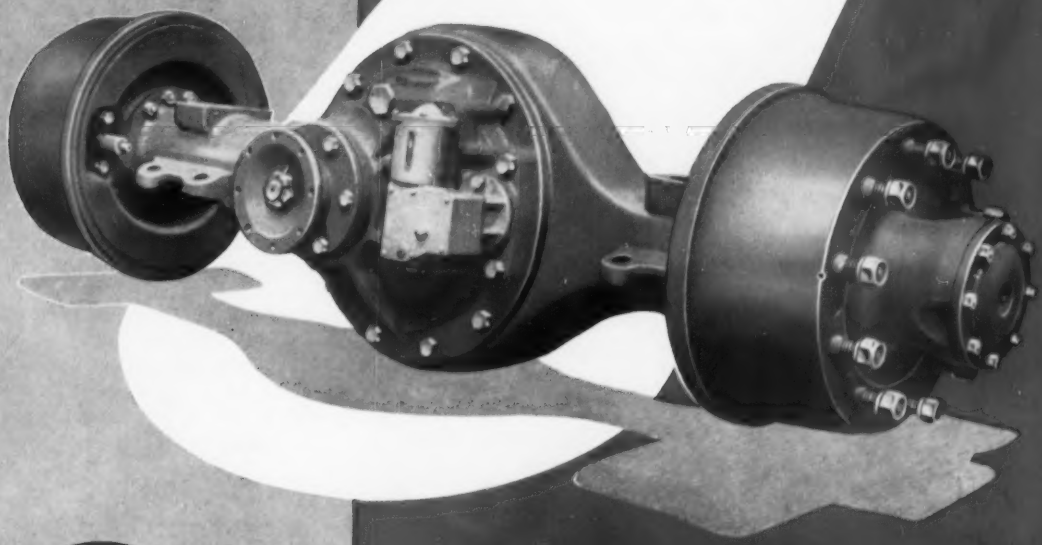
This is the era of the 2-Speed AXLE

At a touch of a button the Eaton 2-Speed Axle provides a complete extra range of gears. There is a gear exactly suited to every load and road, since one range is higher and one lower than the conventional single-ratio axle.

Yes, this is the era of the 2-Speed Axle . . . from which you obtain good acceleration and a great reserve of power, without impairing high performance and economy on the open road.

Eaton 2-Speed Axles have been approved and adopted as standard extra on new vehicles by most well-known vehicle manufacturers, some of which are listed below :

OVER TWO MILLION EATON TWO-SPEED AXLES IN VEHICLES TODAY



EATON
2-Speed AXLES

Atkinson Lorries (1933) Ltd.
Albion Motors Ltd.
Austin Motor Co. Ltd.
Commer Cars Ltd.
Dennis Brothers Ltd.
Dodge Brothers (Britain) Ltd.
E.R.F. Ltd.
Ford Motor Co. Ltd. (Australia)
Guy Motors Ltd.
Leyland Motors Ltd.
Motor Traction Ltd.
Morris Commercial Cars Ltd.
N.V. Motorkracht, Holland
Ransome & Rapier Ltd.
Sentinel (Shrewsbury) Ltd.
Seddon Diesel Vehicles Ltd.
Transport Equipment (Thornycroft) Ltd.
Volvo, Sweden
Tilling-Stevens Ltd.
Vauxhall Motors Ltd.

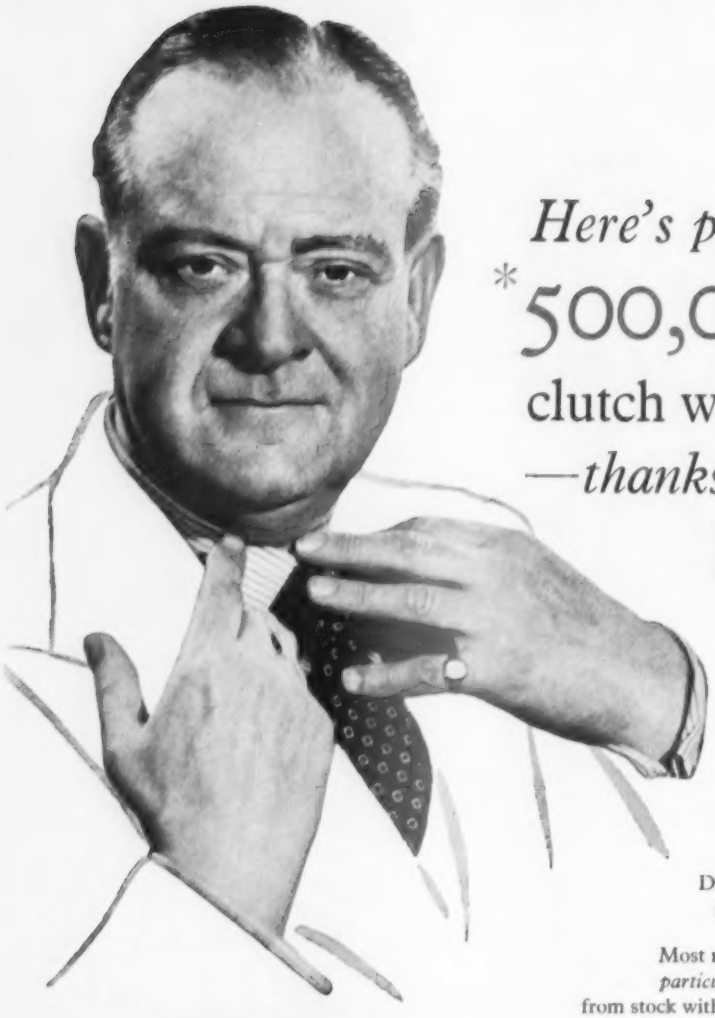
EA 56

EATON AXLES LIMITED

In association with

EATON MANUFACTURING COMPANY, CLEVELAND, OHIO, U.S.A. · E.N.V. ENGINEERING CO. LTD., LONDON, N.W.10 · RUBERY OWEN & CO. LTD., DARLASTON

VICTORIA ROAD, WARRINGTON, ENGLAND



Here's performance for you

* 500,000 miles...

clutch wear practically nil

—thanks to

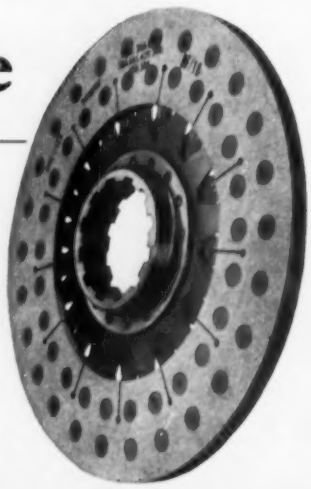
DON-FLEX

Superlative performances of this kind are the rule, *not* the exception, with Don-Flex clutch discs. That is the first dividend you get from using them. They are constructed so that initial engagement is taken up at the inner diameter of the friction facings—ensuring smooth and progressive action with no 'judder' whatsoever. Thus when you fit Don-Flex clutch discs you reduce both your replacement costs and your servicing bills.

Most makes of cars and commercial vehicles and *particularly those with Diesel engines* can be fitted from stock with Don-Flex clutch discs specially designed for them. Our Depots will advise you what type to fit. We ourselves will be very happy to send you full technical information on request.

* *A Don-Flex clutch disc fitted to a 13 tonner operating in Derby went straight back into service after 500,000 miles service.*

Fit a PATENT NONSCORING FLEXIBLE Don-Flex CLUTCH DISC *to be* **sure**



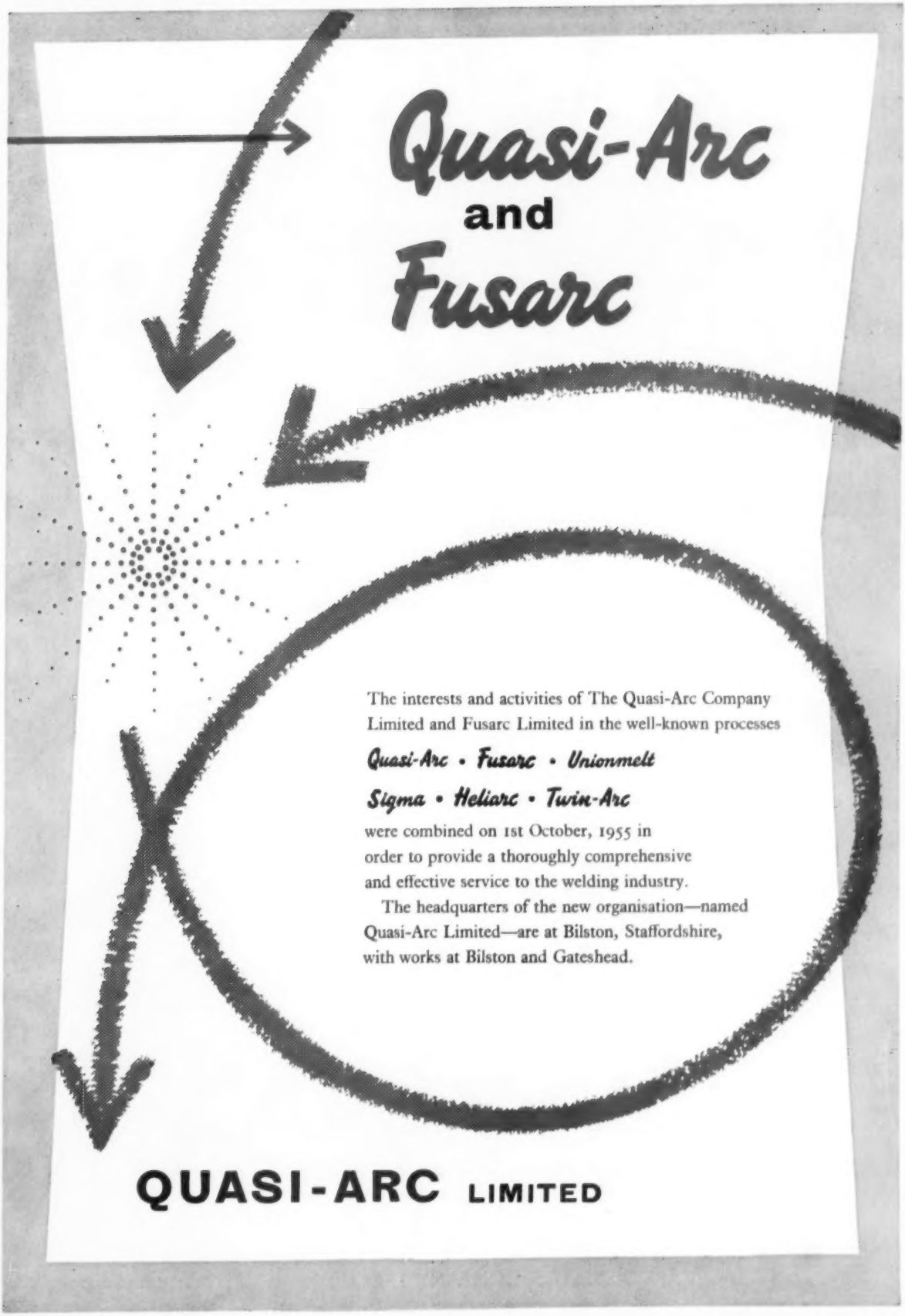
A Nation-wide chain of depots to serve you

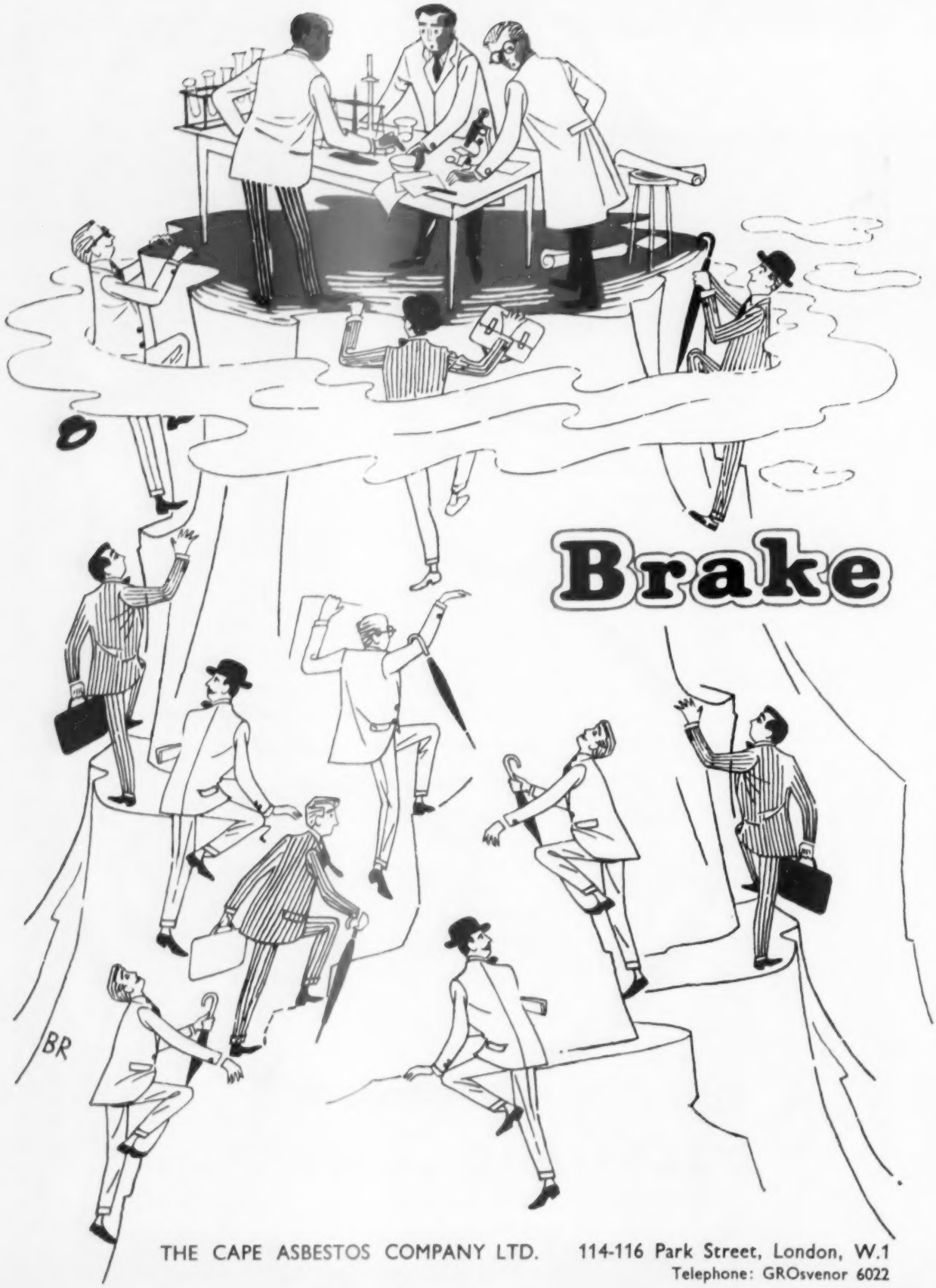
BELFAST *28967*
BIRMINGHAM 5 *Midland 4659*
BLACKBURN *6581*
BRISTOL *27214*
CARDIFF *27026*
CARLISLE *21589*
CHESTER *21280*
COVENTRY *64914*
EDINBURGH 1 *Central 4234*
EXETER *3813*
GLASGOW C2 *Central 4595*
HULL *Central 52072*
IPSWICH *3023*
LEEDS 3 *20664/5*
LEYTON *Leytonstone 6068*
LIVERPOOL *Royal 5202*
MANCHESTER 3 *Blackfriars 0596*
NEWCASTLE-ON-TYNE 2 *27142 and 27942*
NOTTINGHAM *43646*
SHEFFIELD 1 *25529*
SOUTHAMPTON *71276*
STOKE-ON-TRENT *44021*
WIMBLEDON *4248/9*
Republic of Ireland:
DUBLIN, 35 Westland Row *66597*

SMALL & PARKES LIMITED · MANCHESTER 9

Makers of "DON" brake and clutch linings — woven and moulded.

LONDON: 76 Victoria Street, S.W.1


Quasi-Arc
and
Fusarc
The interests and activities of The Quasi-Arc Company Limited and Fusarc Limited in the well-known processes
Quasi-Arc • Fusarc • Unionmelt
Sigma • Heliarc • Twin-Arc
were combined on 1st October, 1955 in order to provide a thoroughly comprehensive and effective service to the welding industry.
The headquarters of the new organisation—named Quasi-Arc Limited—are at Bilston, Staffordshire, with works at Bilston and Gateshead.
QUASI-ARC LIMITED



THE CAPE ASBESTOS COMPANY LTD. 114-116 Park Street, London, W.1
Telephone: GROsvenor 6022

with tradition

It may be unfair to suggest that research people spend their time up in the clouds. It is fair, though, to say that they never exactly welcome visitors. So we are definitely breaking with tradition in inviting them (as we do now) to step down for a minute and take a little applause. No-one has done more for the CAPASCO tradition of dependable braking than they have; and everyone who has experienced the smooth, controlled, fade-free action of CAPASCO linings knows just how much that compliment implies.

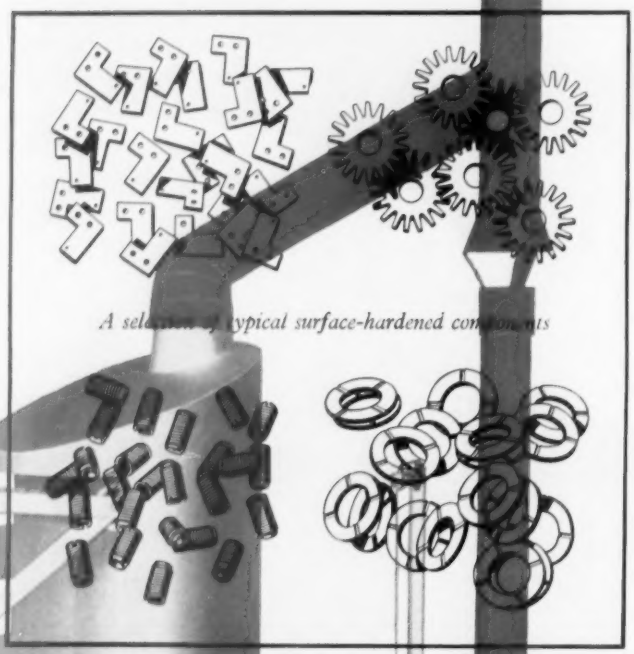
CAPASCO

MOULDED BRAKE LININGS

THE CAPE ASBESTOS COMPANY LTD. | 114-116 Park Street, London, W.1
Telephone: GROsvenor 6022

for
casehardening
heat-treatment
brazing . . .

The 'Cassel' Heat-Treatment Service offers a complete range of salts, furnaces and technical advisory facilities to meet all problems. Surface hardening, for example, is carried out in batch-type or automatic furnaces, using 'Cassel' C.S. 700 or low-strength cyanide-carbonate baths.



A selection of typical surface-hardened components

The salt bath method of surface hardening offers these advantages:

- ★ Accurate control of temperature
- ★ Reduced risk of distortion
- ★ Clean, scale-free finish
- ★ Rapid treatment
- ★ Uniform results
- ★ High output for a small floor space

. . . consult the
'Cassel' heat-treatment service

ICI

IMPERIAL CHEMICAL INDUSTRIES LTD., LONDON, S.W.1

CC.171

648 new bearings

Equivalent and interchangeable with bearings of American type and manufacture.

Our catalogue MAX/54 giving full details of dimensions, cage, lip, circlip, and full of roller types, arrangements, special features, etc., is available on application.

Also the Equivalents and Useful Data Booklet C.1340/53.

POLLARD 'MAX-LOAD'

ROLLER BEARINGS

The Max-Load illustrated above has a single lipped inner race, an outer race with one circlip and one lip, and a pressed steel cage.

In addition Pollard Bearings manufacture Ball, Roller and Thrust Bearings (Cat. BRT/1053). Solid and Flexible Roller Bearings (Cat. RFX). Transmission Equipment and Plummer Blocks (Cat. TR. 27/2). Self-Lube Plummer Blocks (Cat. SL/54). Automobile and Tractor Replacements (Cat. BRM/54). Clutch Withdrawal & Water Pump Spindle Bearings (Cat. CWFP/54).

HEAD OFFICE : FERRYBRIDGE, KNOTTINGLEY, YORKS.
TELE : KNOTTINGLEY 320.

LONDON OFFICE : 6 ST. JAMES' PLACE, S.W.1.
TELE : HYDE PARK 9248/9.

CANADIAN POLLARD BEARINGS LTD.
1103/5 BEAVER HALL HILL, MONTREAL. TELE : UN. 6-5774.

PO 1101/b

BIRLEC

induction heating

cuts costs

improves product

BIRLEC induction heaters in the forging industry are giving cleaner forgings, greater output and lower production costs. Maintenance is reduced and the work is of uniform high quality.

FORGING STEEL BILLETS

Hub component for a popular car, forged by the installation illustrated.

- Uniform temperature throughout each billet ensures better filling of dies with reduced flash.
- Regular, timed ejection of correctly heated billets keeps press operating at full capacity.
- Magazine feed enables one loader to supply several heater/press installations.
- Rapid heating reduces scaling, improving die life and surface finish of work.
- Quick changeover between sizes of work with correct heating conditions for each.
- Economy in power and labour, with no standby or heat-up losses.
- Space-saving layout for minimum handling and operator fatigue.

Type of heater	two station
Nominal rating	200 kw.
Heating capacity...	½ ton/hour
Billet diameter	2"—4"
Billet feed	automatic
Power (1d/kWH) ...	£2.5.0. per ton

Please send me Publication No. 125 on forging or further process details about .....

.....

NAME .....

POSITION .....

COMPANY .....

FSB

BIRLEC LIMITED

Member of the A.E.I. Group of Companies

ERDINGTON

BIRMINGHAM, 24

LONDON • SHEFFIELD • GLASGOW • NEWCASTLE-ON-TYNE

SM B2500 55

Certified...

.....Zinc Alloy Die Castings

The British Standards Institution, in collaboration with the Zinc Alloy Die Casters Association, has introduced a certification scheme for zinc alloy die castings. Under this scheme, zinc alloy die casters may be licensed by the B.S.I. to use the Kite Mark ⛉ on their castings as a guarantee that they are produced under strict analytical control and subject to inspection by the B.S.I., and that they comply with British Standard 1004.

Certified castings normally bear the Kite Mark ⛉, "B.S.1004" and the die caster's name, trade mark,* or B.S.I. licence number. To ensure complete satisfaction we recommend that, on all your orders, you should specify: 'Certified zinc alloy die castings'.

**Indicated in the illustration above by the star.*

At the time of printing Z.A.D.C.A. members licensed to operate the scheme included:

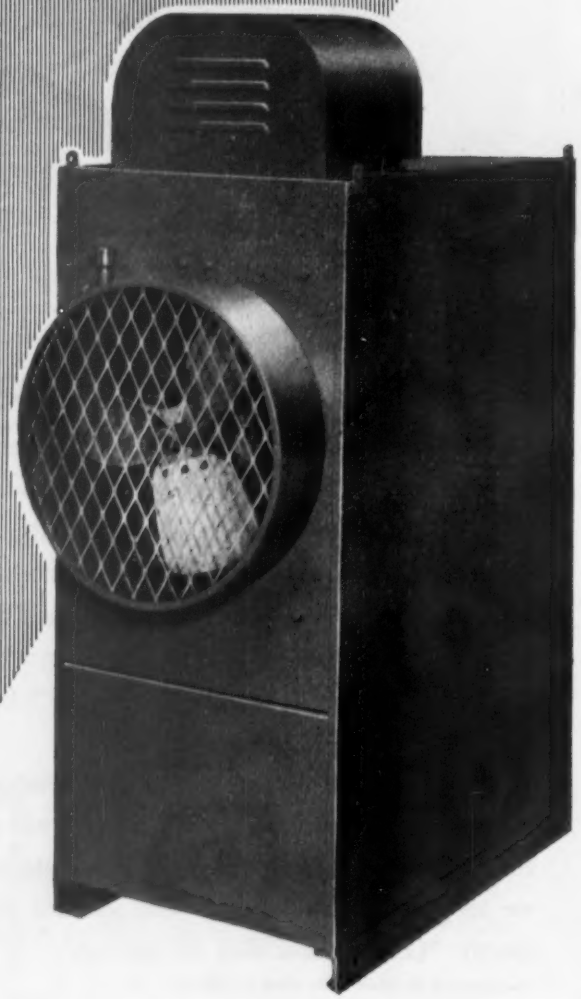
ADVANCED PRESSURE DIECASTING CO. LTD., BIRMINGHAM.
ALLOY PRESSURE DIE PRODUCTS LTD., WILLENHALL.
ARMSTRONG PATENTS CO. LTD., BEVERLEY.
THE BIRMINGHAM ALUMINIUM CASTING (1903) CO. LTD., BIRMINGHAM.
BRITISH DIE CASTING & ENGINEERING CO. LTD., NEW BARNET AND NORTH SHIELDS.
BURDON & MILES LTD., ENFIELD HIGHWAY.
CLIFFORD COVERING CO. LTD., BIRMINGHAM.
DYSON & CO. ENFIELD (1919) LTD., ENFIELD.
FRY'S DIECASTING LTD., *Stone-Fry Magnesium Ltd.*, LONDON, S.W.19.
GILLS PRESSURE CASTINGS, BIRMINGHAM.
CHARLES HILL & CO. LTD., *Hills Precision Die Castings Ltd.*, BIRMINGHAM.
JOHN IRELAND (WOLVERHAMPTON) LTD., WOLVERHAMPTON.
KAYE ALLOY CASTINGS LTD., BIRMINGHAM.
JOSEPH LUCAS (ELECTRICAL) LTD., BIRMINGHAM.
METAL CASTINGS LTD., WORCESTER.
METROPOLITAN PLASTICS LTD., LONDON, S.E.8.
ORB ENGINEERING WORKS LTD., MANCHESTER.
RAWLINGS MANUFACTURING CO. LTD., LONDON, S.W.12.
THE SHAW FOUNDRY CO., WILLENHALL.
STREBOR DIECASTING CO. LTD., RADCLIFFE.
T.A.L. DEVELOPMENTS LTD., LONDON, N.17.
WESTERN DIECASTING LTD., BRISTOL.
WOLVERHAMPTON DIE-CASTING CO. LTD., WOLVERHAMPTON.
YALE & TOWNE MANUFACTURING CO., WILLENHALL.

ZINC ALLOY DIE CASTERS ASSOCIATION

LINCOLN HOUSE TURL STREET OXFORD · TELEPHONE: OXFORD 48088

Save Water . . .
Cut Costs

Aquatower REGD.



The Latest Development in Water Coolers

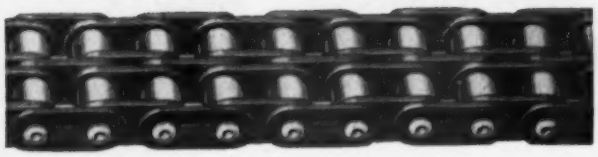
- ★ Low initial cost
- ★ Low fan power
- ★ Reduced costs of electric current
- ★ Low height, suitable for confined spaces
- ★ Easier blending with architecture of buildings
- ★ Unique cross flow principle
- ★ Gravity flow non-clog water distribution.
- ★ Quiet running
- ★ Simplicity of design
- ★ Easy installation due to self-contained construction.
- ★ Easy access and maintenance

H&F

HEENAN-MARLEY AQUATOWERS are manufactured by

HEENAN & FROUDE LIMITED · WORCESTER · ENGLAND

RENOLD
TIMING CHAINS



STANDARD EQUIPMENT FOR THE FOLLOWING BRITISH MOTOR-CARS:

A.C. · ALLARD · ALVIS

ASTON-MARTIN · AUSTIN

AUSTIN-HEALEY · BRISTOL

CITROEN · DAIMLER

FORD · FRAZER-NASH

HILLMAN · HUMBER

JAGUAR · JENSEN

LAGONDA

LANCHESTER · M.G.

MORGAN · MORRIS

RILEY · ROVER · SINGER

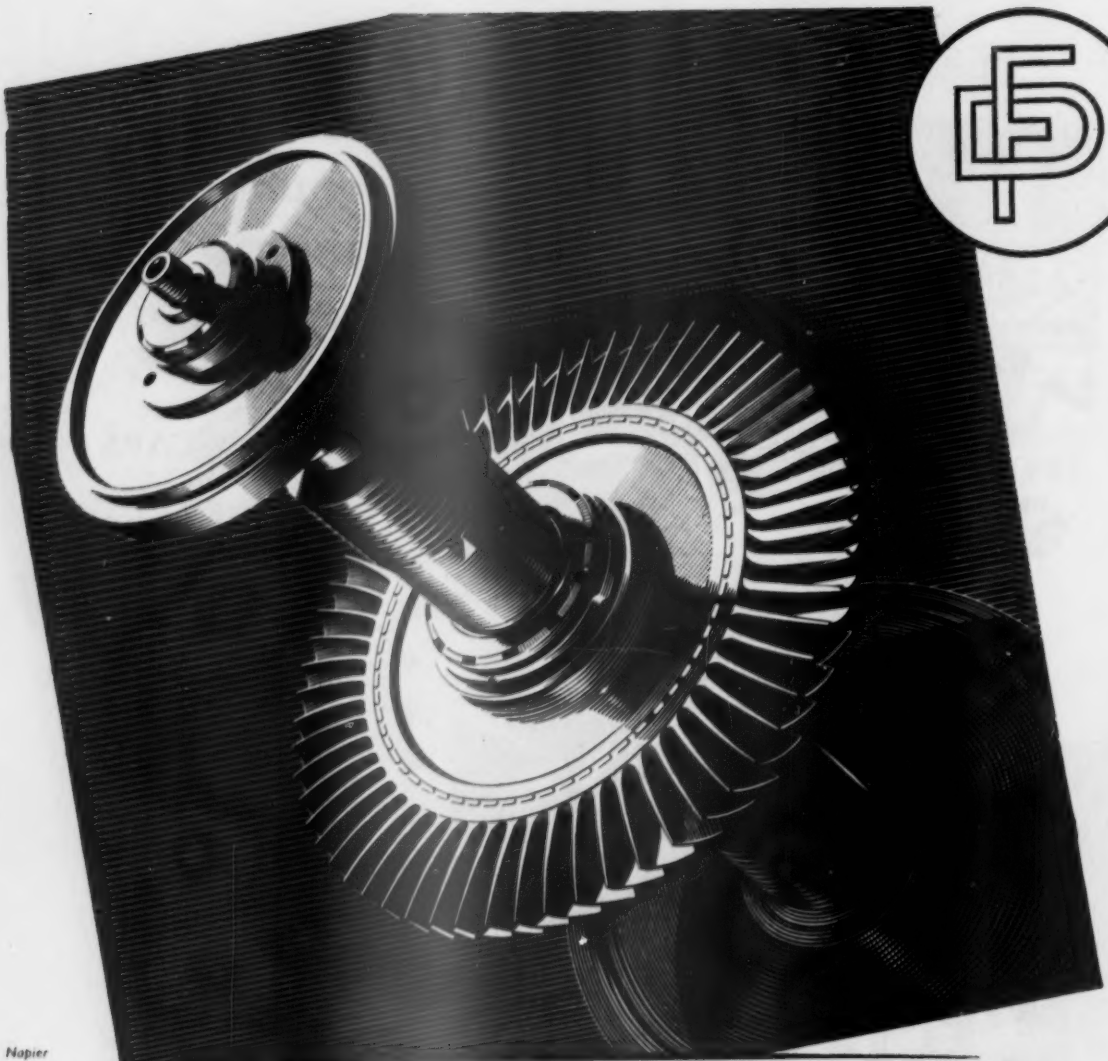
STANDARD

SUNBEAM

TRIUMPH · VAUXHALL

WOLSELEY

RENOLD CHAINS LIMITED · MANCHESTER



Napier Turbo Blower, Turbine Discs and Rotor Shaft Assembly

DROP FORGINGS

in

ALLOY · CARBON · STAINLESS
HEAT AND CREEP RESISTING STEELS
and SPECIAL NON-FERROUS ALLOYS

by

FIRTH-DERIHON

THE FIRTH-DERIHON STAMPINGS LTD · TINSLEY · SHEFFIELD

OAKENSTRONG
OAKENCORK

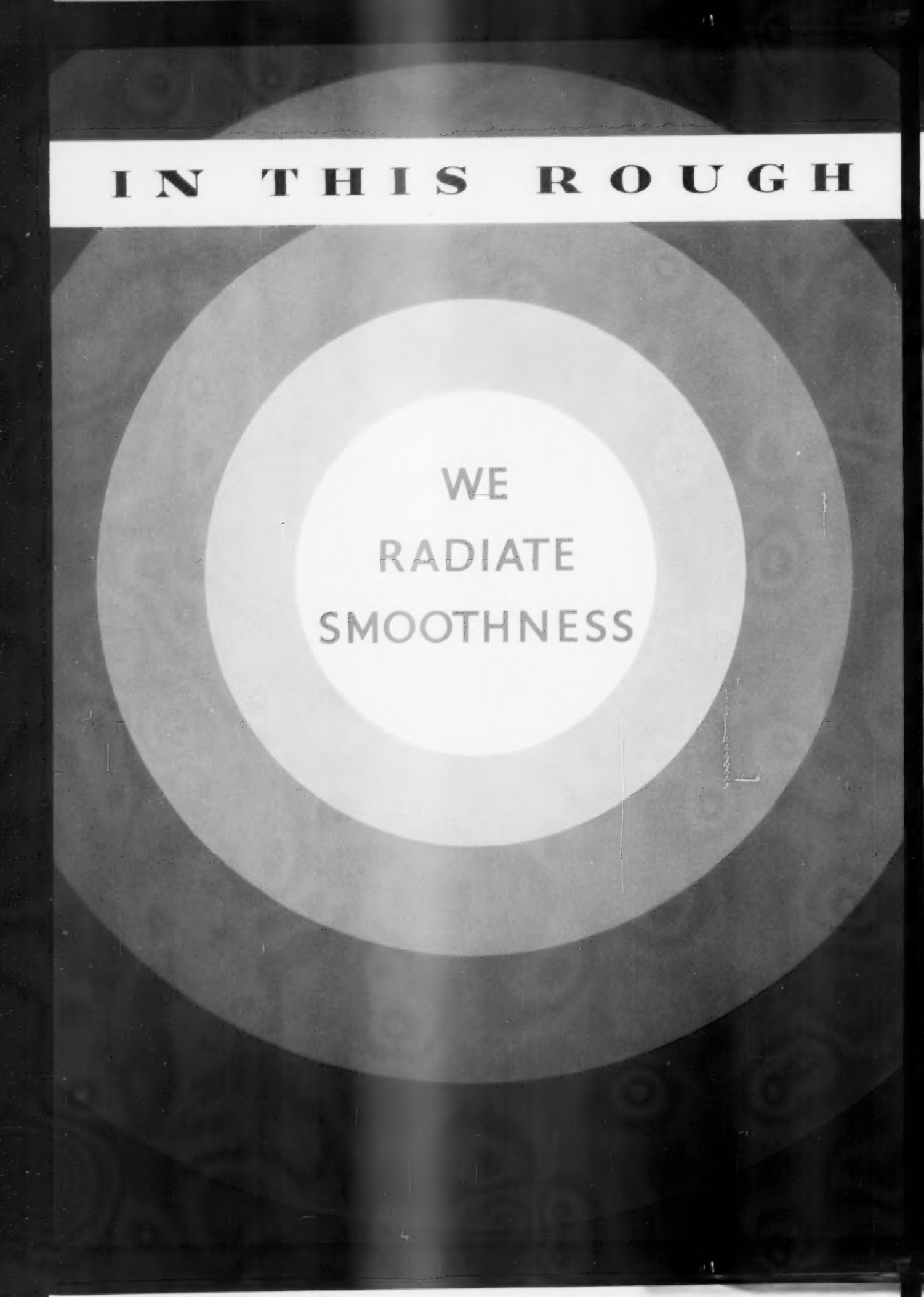
OIL and PETROL

GASKET MATERIALS

DISTRIBUTORS OF MATERIAL
IN BULK FOR GT. BRITAIN
J.A.NORDBERG LTD
171 QUEEN VICTORIA ST.,
LONDON.
E.C.4
Tel: Central 9678

REGISTERED
TRADE MARK

FOREIGN & COLONIAL
ENQUIRIES TO
H.JACKSON LTD
OAKENCLOUGH, GARSTANG
Nr. PRESTON
LANCS.
Tel: Garstang 8

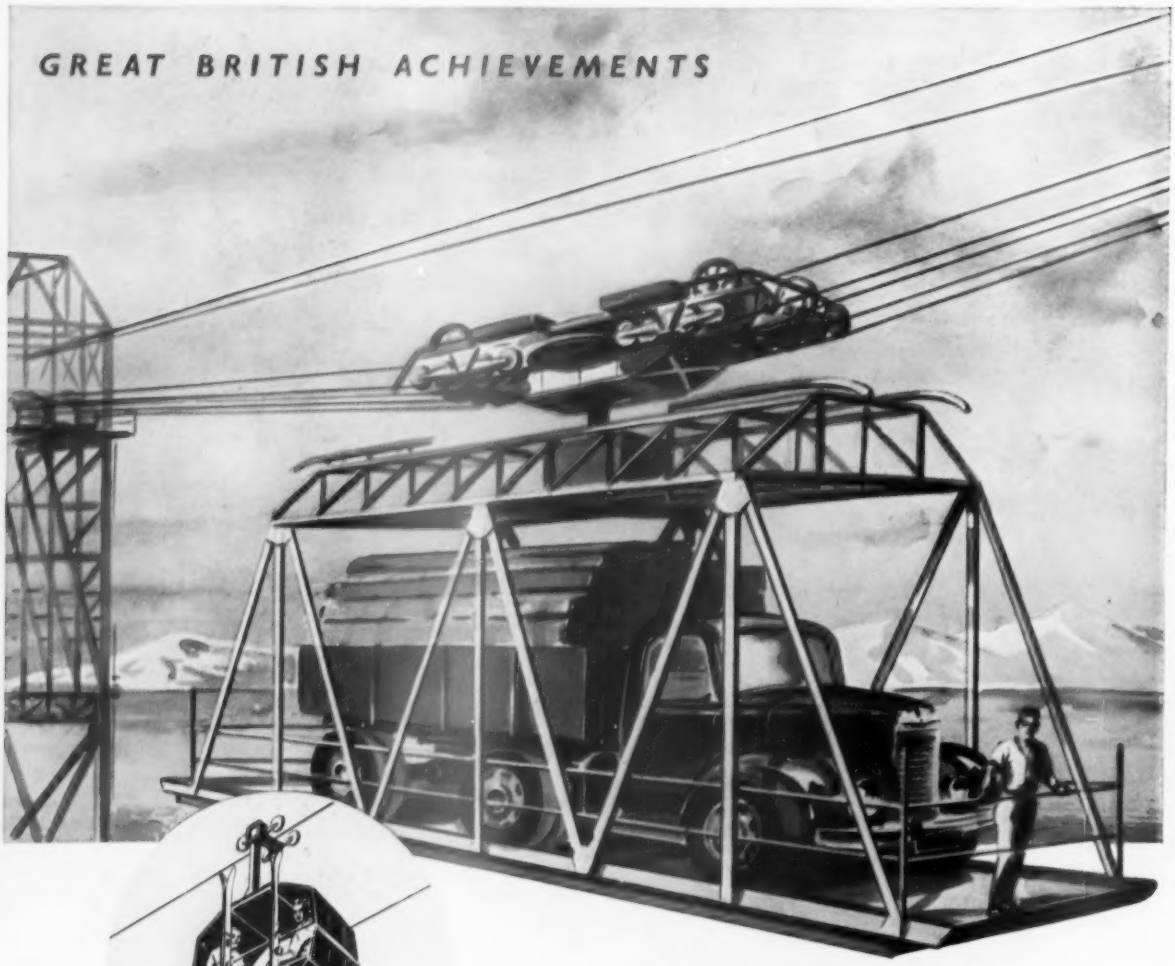

IN THIS ROUGH
WE
RADIATE
SMOOTHNESS

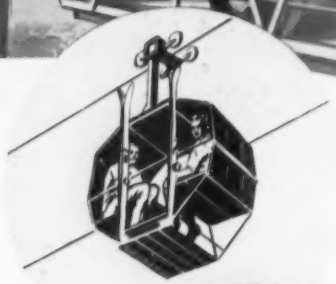
WORLD

METALASTIK

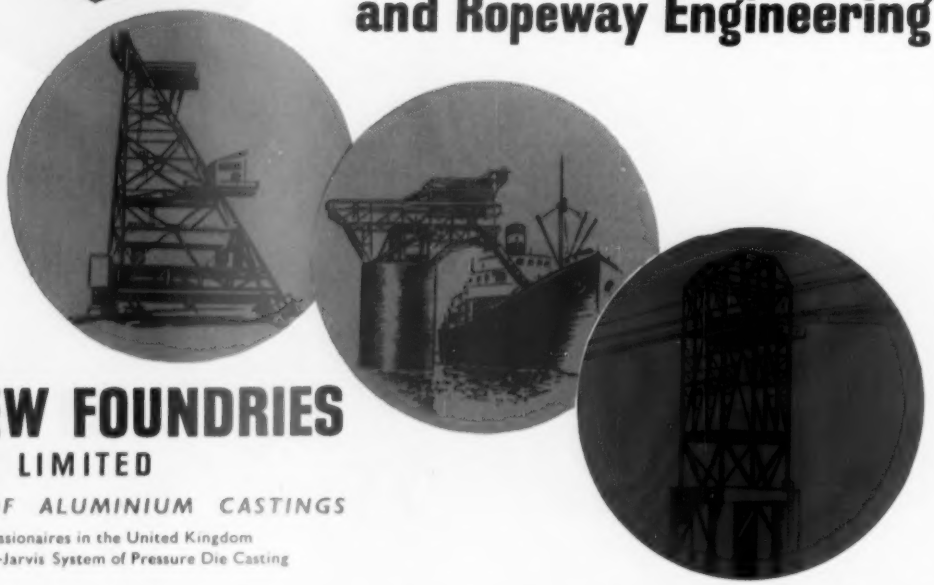
METALASTIK LTD., LEICESTER

GREAT BRITISH ACHIEVEMENTS





Overhead Cable
and Ropeway Engineering



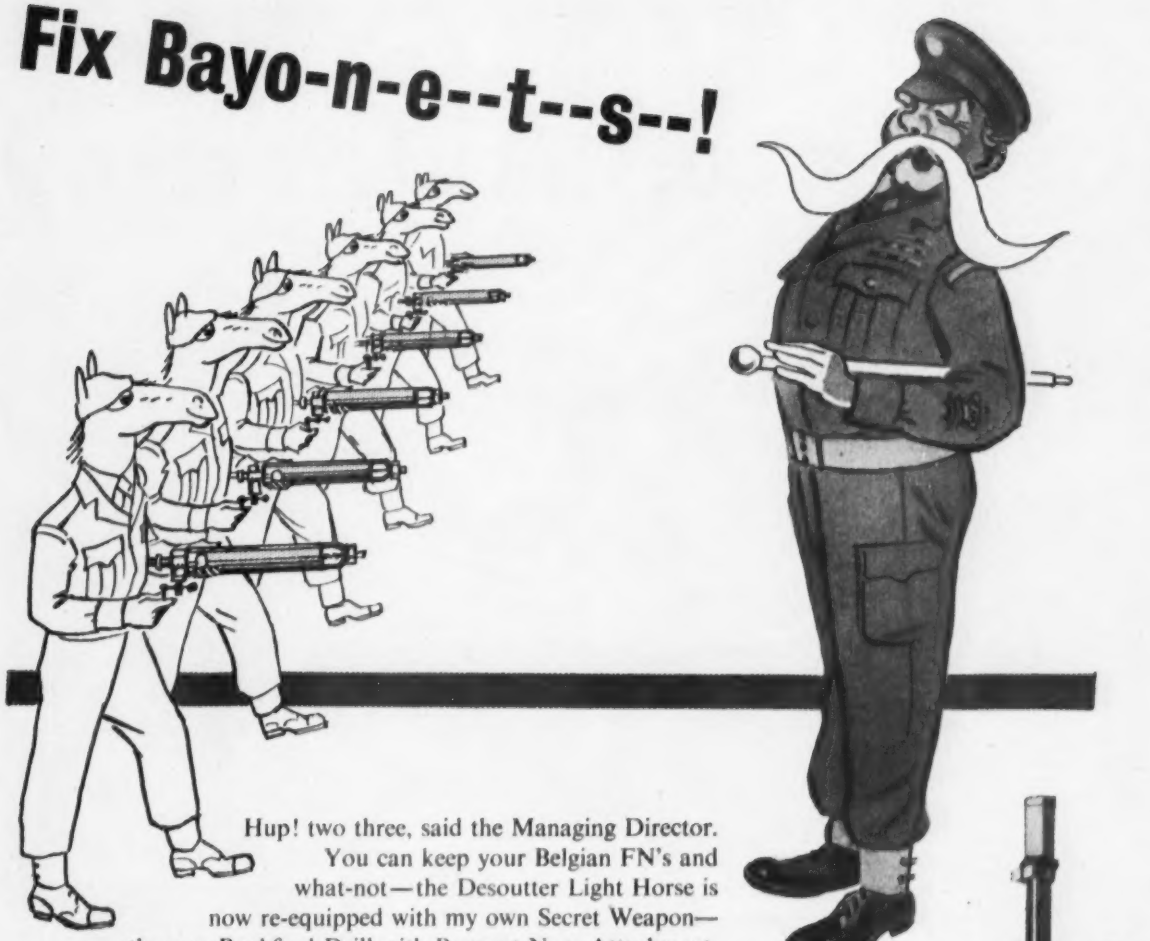
RENFREW FOUNDRIES
LIMITED

SUPPLIERS OF ALUMINIUM CASTINGS

Sole Concessionaires in the United Kingdom
for the Doehler-Jarvis System of Pressure Die Casting

HILLINGTON · GLASGOW · S.W.2 · Telephone HALFWAY 3391

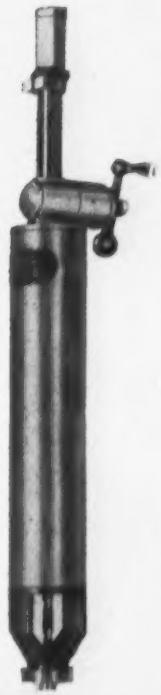
Fix Bayo-n-e--t--s--!



Hup! two three, said the Managing Director. You can keep your Belgian FN's and what-not—the Desoutter Light Horse is now re-equipped with my own Secret Weapon—the new Rackfeed Drill with Bayonet Nose Attachment. On the command One! press the bayonet nose home firmly in the jig bush. Two! a quick half turn to lock it into place. Three! rotate the little handle smartly—and Fire! The Rawest Recruit can drill a whacking great hole bang on target through steel umpteen inches thick, with no Fatigue at all, cookhouse or otherwise.*

Get out of the Awkward Squad! Join the ranks of the Rackfeed Drillers! Demonstrations gladly arranged on your own Company Parade Ground.

**In fact with finger pressure only the Rackfeed Drill will apply a load of 250 lbs.*



the new Rackfeed Drill by Desoutter

Desoutter Bros. Ltd., The Hyde, Hendon, N.W.9 Telephone: Colindale 6346 (5 lines). Telegrams: Despnuco, Hyde, London.
CBC 268

Seals of Authority

Earl of Warwick

Richard Neville, Earl of Warwick (1428-1471) had many of the qualities of a strong ruler, commanded considerable popularity, and was a skilled diplomat and politician. He was called the "King-maker" by reason of the fact that he made his cousin, Edward of York, King on the death of Richard II at the battle of Wakefield.

ROTARY SHAFT SEALS

In leather and synthetic rubber for all requirements from ¼" up to 36" shaft; in built-up type or bonded.

"ROMET" FACE TYPE SEALS

For all water pump and similar applications.

CYLINDER LINER SEALS

Covering a wide range of sizes and suitable for applications where precision and high-class finish, together with the correct compounding of material, are essential.

FACE TYPE SEALS

For arduous duty. Suitable for bogie wheels and idler wheels for track vehicles.

All types of seals are made to customers own requirements. Our technical representatives will be pleased to call and discuss your problems.

The Authority on Seals

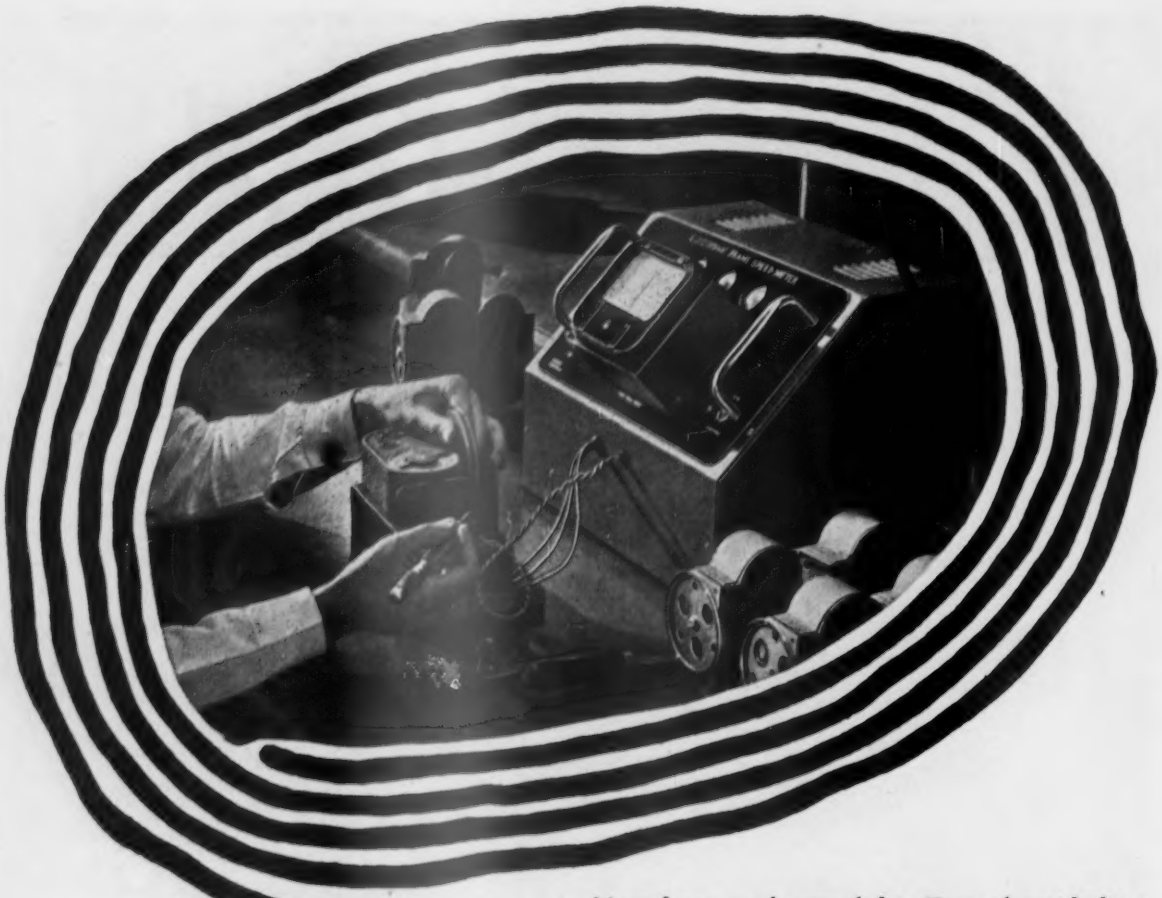
SUPER OIL SEALS & GASKETS LTD., Factory Centre, Birmingham, 30

KIRKSTALL AXLES ON TEST

KIRKSTALL FORGE ENGINEERING LIMITED
LEEDS, 5

Telephone: Horsforth 2821

F.P.2



Magic Eye

The product, cine-camera driving motors. The problem, to check the motor speed. But—to check it quickly, accurately, infallibly; with the minimum of mental strain on an operator who is working at high speed. And — a complication: the speed-measuring instrument must not take any power from the camera motor.

The answer? A beam of light: interrupted by the shutter on the camera. The magic eye counts the interruptions, electronic gear translates them into r.p.m.—as a direct reading on a dial. Eureka? But electronic speed measuring is **only one of the many aids to Productivity that electricity can bring you**

Having a hand in Productivity

In every industry or trade, electrical equipment is the key to modern production methods. There are probably more production-boosting and money-saving devices than you know of. Your Electricity Board can help you and give you sound advice.

They can also make available to you, on free loan, several films on the uses of electricity in Industry — produced by the Electrical Development Association.

E.D.A. are publishing a series of books on "Electricity and Productivity". Four titles are available at the moment; they deal with Higher Production, Lighting, Materials Handling, and Resistance Heating. The books are 8/6 each (9/- post free) and the Electricity Boards (or E.D.A. themselves) can supply you.

The British Electrical Development Association
2 Savoy Hill, London, W.C.2

Electricity
a Power of Good
for PRODUCTIVITY

FOR QUICK DELIVERY

4 BRANCHES *at your service*

STEEL SHEETS

Cold-reduced : Hot-Rolled
Galvanized or black,
also mild steel plates
up to and including ¼in.
SHEARED TO YOUR SIZES

May we send you our stock list?
If you would like to have it regularly,
kindly drop a card to our nearest branch

SPENCER

H. F. SPENCER & CO. LTD., WOLVERHAMPTON

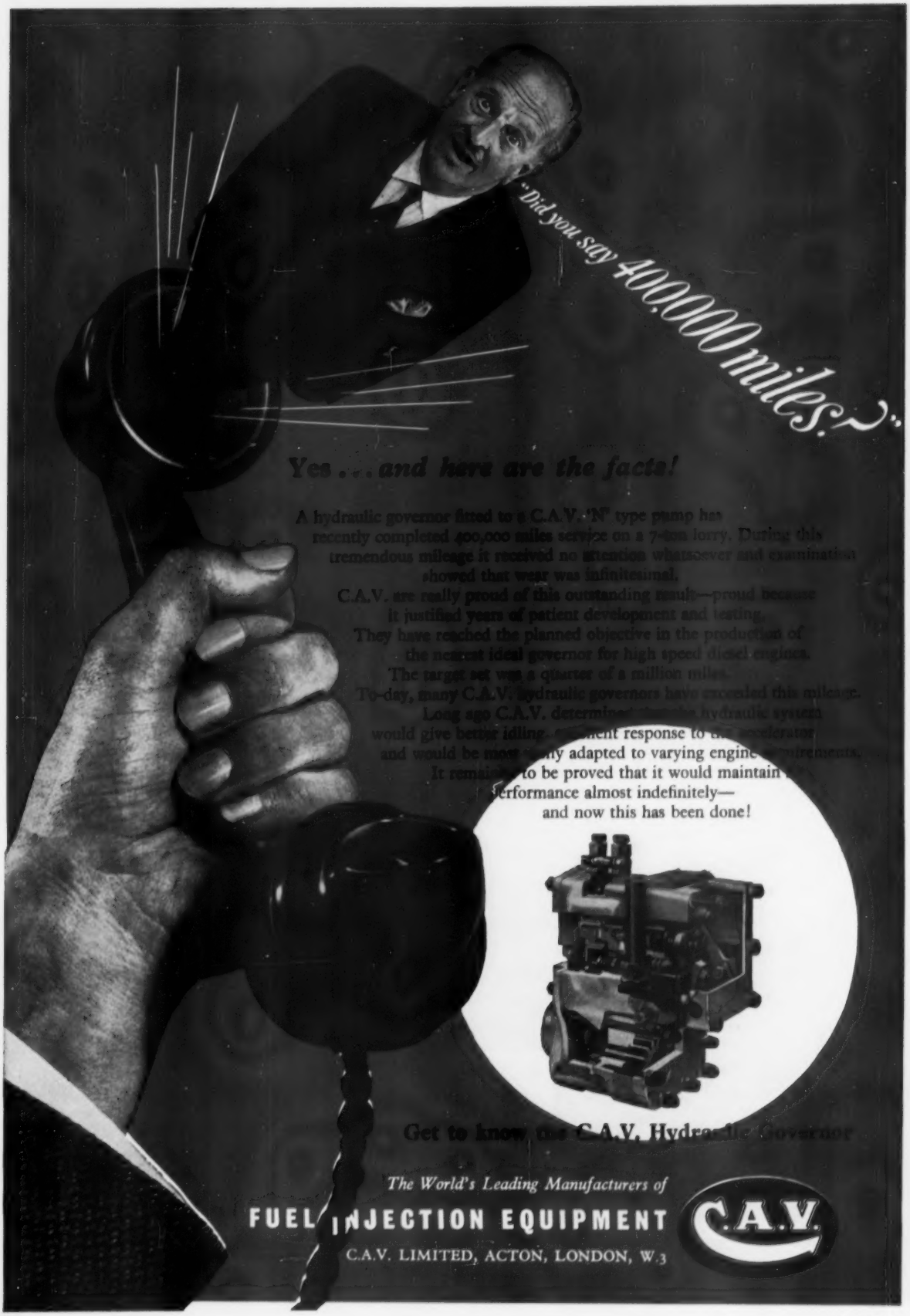
The Lighthouse, *proud guide over the storm ravaged ocean and warning sentinel against the lethal power of rock and current, lights up the problems of inaccessibility. These problems are more easily solved in industry and the home, in equipment where maintenance for lubrication is difficult or undesirable, by the use of "Reservoil" sintered-metal oil-retaining bearings. With these, oil is fed by capillary action to the bearing surfaces, providing trouble-free lubrication automatically.*

Reservoil
SINTERED METAL
OIL RETAINING BEARINGS

Bulldozers are an instance where 'Reservoil' bearings are used to advantage. These bearings are supplied in shapes and sizes for every normal medium duty, but attention is drawn to the standard range of plain cylindrical bearings. Write for Catalogue SD 41.

THE MORGAN CRUCIBLE COMPANY LTD., BATTERSEA CHURCH ROAD, LONDON, S.W.11. *BATTERSEA 8822*

SM 120

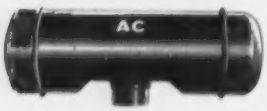

"Did you say 400,000 miles?"
Yes . . . and here are the facts!
A hydraulic governor fitted to a C.A.V. 'N' type pump has recently completed 400,000 miles service on a 7-ton lorry. During this tremendous mileage it received no attention whatsoever and examination showed that wear was infinitesimal.
C.A.V. are really proud of this outstanding result—proud because it justified years of patient development and testing.
They have reached the planned objective in the production of the nearest ideal governor for high speed diesel engines.
The target set was a quarter of a million miles.
To-day, many C.A.V. hydraulic governors have exceeded this mileage.
Long ago C.A.V. determined ... hydraulic system would give better idling ... ment response to ... accelerator and would be most ... adapted to varying engine ... quirements.
It remained ... to be proved that it would maintain ... performance almost indefinitely—
and now this has been done!
Get to know the C.A.V. Hydraulic Governor
The World's Leading Manufacturers of
FUEL INJECTION EQUIPMENT
C.A.V. LIMITED, ACTON, LONDON, W.3
C.A.V.

A.P. 1/4-70/

AUTOMOBILE ENGINEER, *November* 1955

35

AC OIL FILTERS



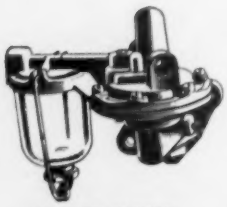
AC AIR CLEANERS AND SILENCERS

AC THERMOSTATS

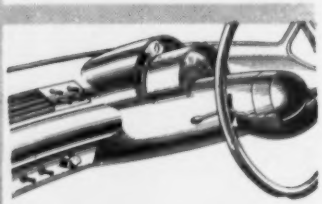
Plan your future models with

AC QUALITY PRODUCTS

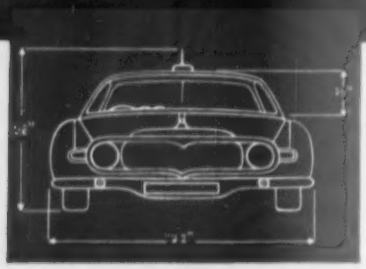
AC SPARK PLUGS



AC FUEL PUMPS



AC INSTRUMENTS

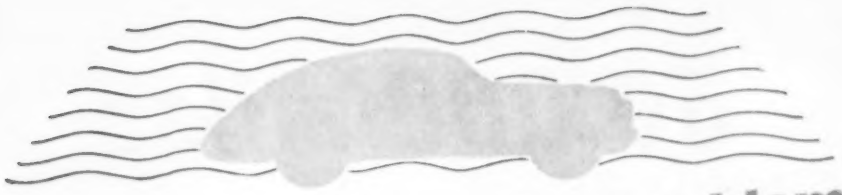


VIRTUALLY EVERY BRITISH CAR has one or more AC Components designed into it on the drawing-board. We'll gladly help you plan a new design or modify an existing one.

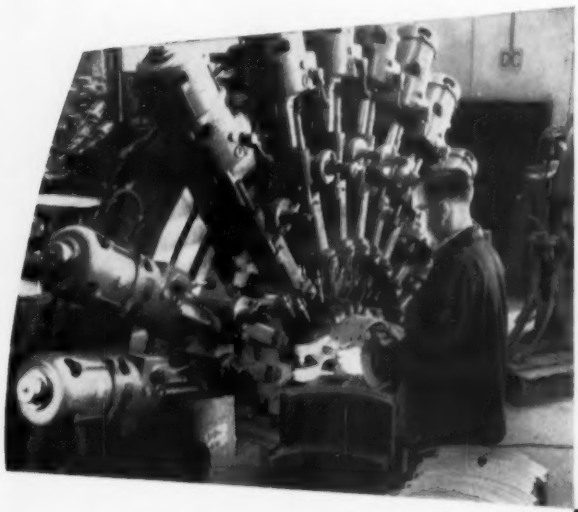
Write to:

AC-DELCO DIVISION OF GENERAL MOTORS LTD., DUNSTABLE, BEDS.

Telephone: Dunstable 1166. And Broadgate House, Coventry. Telephone: Coventry 40491



New styling brings new problems



As the stylists create new body designs, cutting down wind resistance with slab-sides and covered wheels, they increase the need for Brake Linings with the highest possible performance. As the engineer knows, streamlining makes a car harder to stop, besides partially cutting off the flow of cooling air round the brake drums. This, combined with faster speeds, means higher and higher temperatures for Brake Linings to withstand.

Ferodo provide the answers

Laboratory research and stringent testing both in the Ferodo Test House and on the powerful cars of the Ferodo Test Fleet have made these tough Linings able to stand up to tremendous heat without losing their efficiency. This has been proved by hard-driving racing men who rely on Ferodo Linings for world famous races and trials.

Ferodo — and the Future

As new years bring new ideas in the Automobile Industry, Ferodo, with their unique facilities for research and testing, are able to keep in time with, and sometimes ahead of, progress. These facilities are freely at the disposal of the Industry.

FERODO

ANTI-FADE BRAKE LININGS
CLUTCH FACINGS

FERODO LIMITED · CHAPEL-EN-LE-FRITH
A Member of the Turner & Newall Organisation

50,000 miles more paylife for your fleet vehicles!

Sound like an extravagant claim? It isn't—when you examine the facts about Clayton automatic chassis lubricators.

1 No idle vehicles, no downtime—each vital chassis point is *automatically* lubricated at periodic intervals while the vehicle is on the job, carrying payloads.

2 Because lubrication is *complete* and *constant*, chassis bearing wear is reduced to a minimum, a promise of longer chassis life.

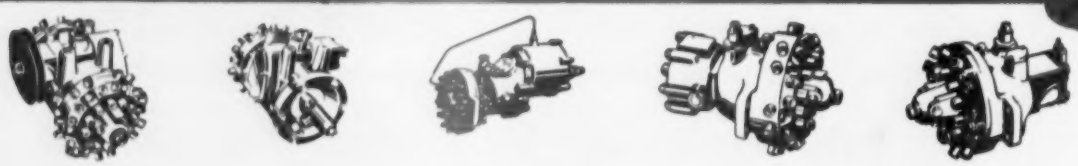
Add to these the many other advantages of a Clayton automatic chassis lubricator—reduced maintenance costs; fewer replacement parts needed; less lubricant used; lower labour costs—and it's easy to see where your 50,000 miles of extra paylife come from.

'Phone or write us for more information. A qualified Clayton engineer will be glad to inspect your fleet and make specific recommendations.

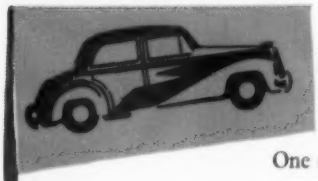
INSTALLATIONS IN LONDON & HOME COUNTIES BY UNIVERSITY MOTORS LTD. LOTS ROAD, LONDON, S.W.10

CLAYTON DEWANDRE CO. LTD.

TITANIC WORKS, LINCOLN · PHONE 11305-9



L.20

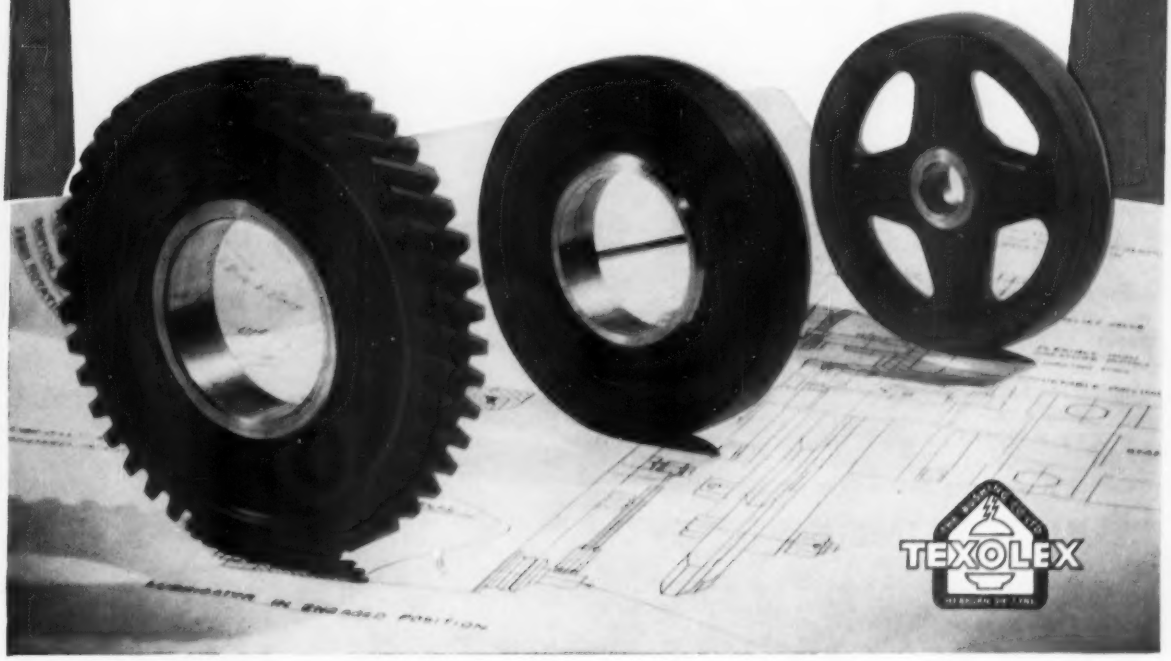


PLASTICS FOR THE ENGINEER

One of the many industrial applications of Texolex laminated mouldings is in the motor industry where extensive use is made of this material for cam gears. Some of the largest motor manufacturing organisations have found in Texolex many of the qualities of the ideal material, offering silence in operation, lightness in weight, high mechanical strength coupled with resistance to wear and corrosion.

TEXOLEX IN THE AUTOMOBILE INDUSTRY

The Bushing Company Limited, would be pleased to give further technical information about Texolex laminated fabric gears and their suitability and operation in camshaft, jackshaft and oil pump drives.



THE BUSHING COMPANY LIMITED · HEBBURN ON TYNE · ENGLAND

TELEPHONE: HEBBURN 32241 TELEGRAMS: "BUSHING, HEBBURN"

In the Austin Healey...

AS IN EVERY BRITISH SPORTS CAR

...you'll see VYBAK Flexible Clear Sheet

This Austin Healey, like every British sports car, has a rear window of VYBAK Flexible Clear Sheet because it means clearer, wider vision. The large rear window is possible because VYBAK Flexible Clear Sheet folds or rolls with the hood, without cracking, crazing or marking in any way. It is tough, long lasting, resistant to warping and discoloration, with a high polish to match the splendid finish of the car. VYBAK Flexible Clear Sheet, which is also used for sports car side-screens is obtainable in several thicknesses. Please write for samples and further details.

BAKELITE LIMITED

12-18 Grosvenor Gardens, London, S.W.1. Telephone: SLOane 0898

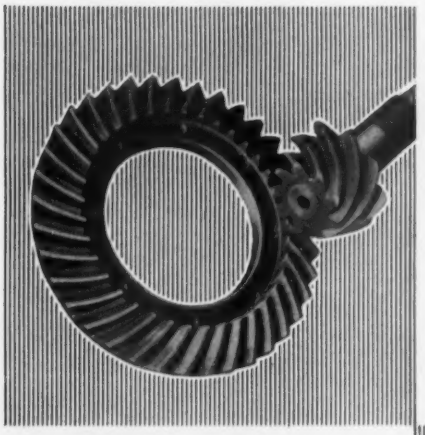
Vybak Products include: Vybak rigid and flexible pvc compounds for moulding and extrusion; Vybak calendered sheet; Vybak flexible pressed sheet — coloured and transparent.

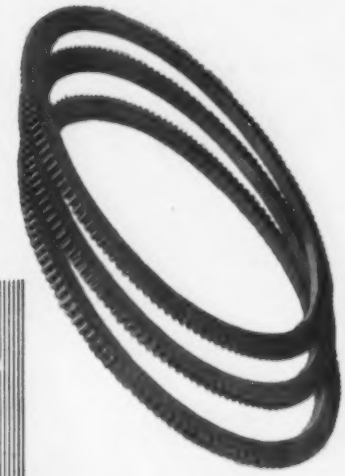
Austin-Healey

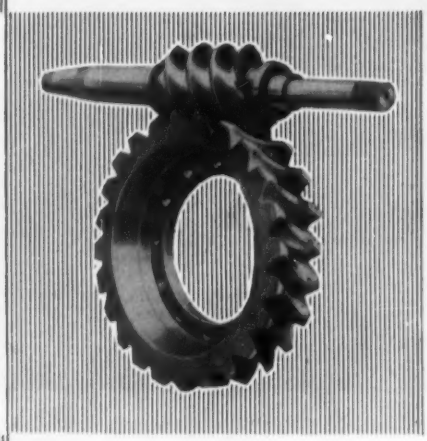
VYBAK REGD.

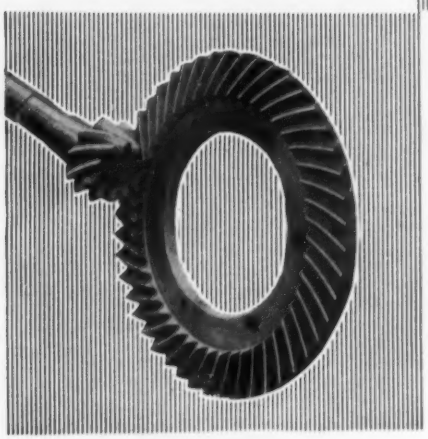
Flexible Clear Sheet

WHATEVER THE DRIVE









On passenger and commercial vehicles throughout the world David Brown automobile transmission components are giving dependable service.

For rear-axle drives—worm gears, spiral or hypoid bevel gears, or differential bevel gears—for timing, magneto, oil pump and speedometer drives—for gearbox, steering, starter and clutch gears, and power take-off drives from the main gearbox—in fact, whatever the drive, the David Brown organisation can supply your needs with components backed by the soundness and reliability associated with David Brown.

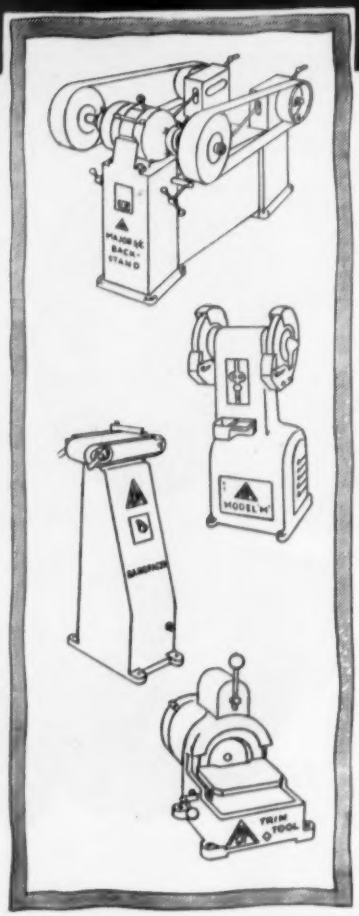
THE
DAVID BROWN
CORPORATION (SALES) LIMITED
AUTOMOBILE GEAR DIVISION
PARK WORKS HUDDERSFIELD

Specialists

IN GRINDING & POLISHING

To meet the increasing need for higher standards of finishing throughout every industry R.J.H. have specialised for years to produce a range of Backstands, Bandfacers and Grinders to fit all requirements. The success of this aim is proved by the growing number of manufacturers who are reducing costs and increasing quality by using R.J.H. equipment.

We will be pleased to send on request literature covering complete range of equipment.



R. J. H. TOOL & EQUIPMENT CO. LTD.

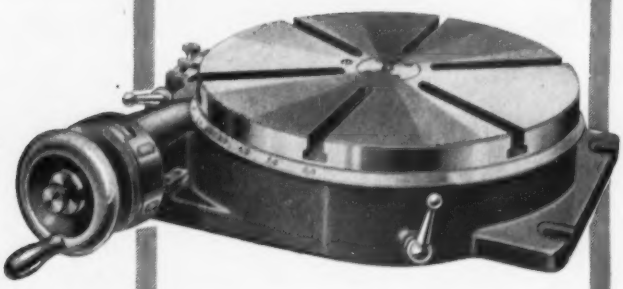
HECKMONDWIKE · YORKS.

Telephone: Heckmondwike 490

London & Southern Counties Representative:
E. J. Spreadborough, A.I.Mech.E., 30, Heath Street, N.W.3.
Telephone: Ham. 8037.

Only the best castings for MATRIX

COVENTRY GAUGE & TOOL COMPANY LTD



Harper quality covers grey iron and Meehanite castings, shell moulding and ductile iron, also metal pressings, machining, enamelling and other finishes and sub-assembly work.

For their 12" Rotary Table, Coventry Gauge & Tool Co. Ltd. say they specify Harper Castings "because they are always of a uniform quality, homogeneous in structure and have a first-class finish." The excellent machining properties of Harper Castings help to maintain the quality and accuracy of the Matrix Rotary Table — a valuable piece of equipment for use on small jig boring machines and light milling machines.

HARPER CASTINGS

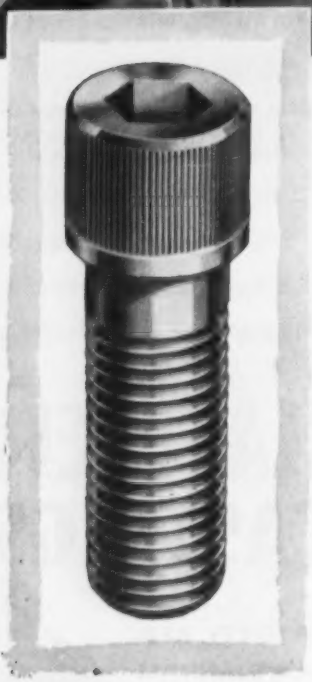
JOHN HARPER & CO. LTD. JOHN HARPER (MEEHANITE) LTD.
ALBION WORKS Phone: WILLENHALL 124 (5 lines) Grams: HARPERS, WILLENHALL **WILLENHALL**

CASTINGS WITH THE HARPER SKIN

LONDON OFFICE: SEAFORTH PLACE, 57, BUCKINGHAM GATE, LONDON S.W.1 Tel.: TATE GALLERY 0286

HS19

HAND TIGHT ?



OR WRENCH TIGHT

A calibrated wrench shows us that Unbrako socket screws will stand far greater torsional strain than other screws of the same size without distorting or breaking. Higher predetermined tightening torques can therefore be applied on assembly with subsequent assurance of increased resistance to slackening, and safety under conditions of dynamic loading.

This is just one more link in the production chain from research to final approval of the finished screw, which ensures that Unbrako screws will give unsurpassed service life.

UNBRAKO

UNBRAKO SCREWS COST LESS THAN TROUBLE

UNBRAKO SOCKET SCREW CO. LTD. COVENTRY

Layrub transmission is being adopted more and more by the leading commercial and passenger vehicle manufacturers for fan drives and main drive. The well-known shock absorbing characteristics of Layrub easing the strain on the rest of the transmission. The Layrub system employs rubber trunnion blocks as the main driving elements. There are no metal-to-metal contacts, no lubrication, therefore little or no maintenance. Our latest catalogue will be gladly sent to you on request.

LAYCOCK ENGINEERING LTD.
SHEFFIELD 8

Layrub

TRANSMISSION AT ITS BEST

33 YEARS OF CENTRELESS

is available

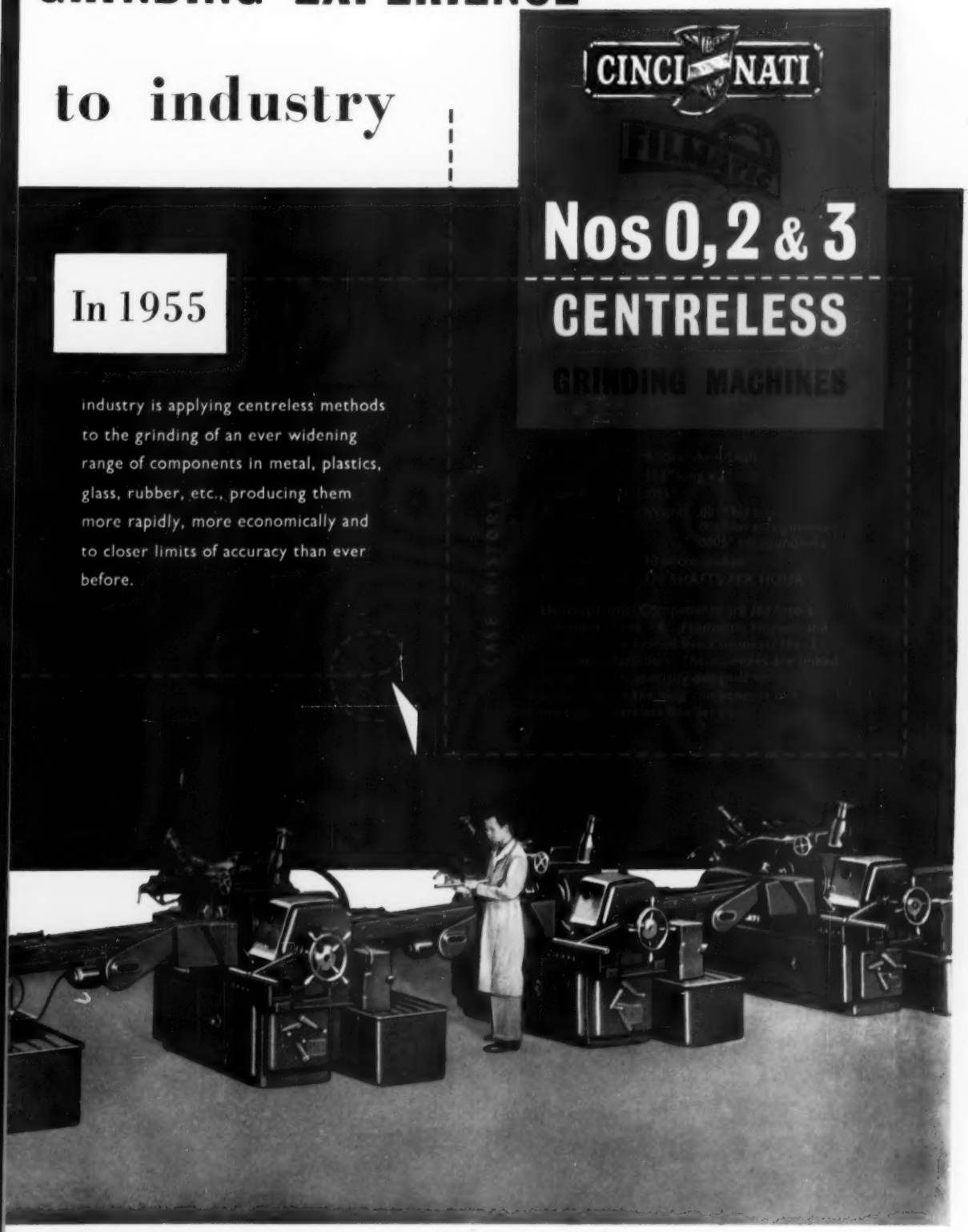
In 1922

Cincinnati introduced its first Centreless Grinding Machine. Since then an extensive history of centreless grinding applications has been accumulated in the Company's engineering service files, covering the production of vast quantities of components for highly geared industries . . . and the profitable application of the centreless method to the grinding of small lots.

CINCINNATI MILLING MACHINES LTD
Birmingham 24

GRINDING EXPERIENCE

to industry



In 1955

industry is applying centreless methods to the grinding of an ever widening range of components in metal, plastics, glass, rubber, etc., producing them more rapidly, more economically and to closer limits of accuracy than ever before.

MOLYBDENUM'S PLACE IN INDUSTRY

87%

NO NATION IN THE WORLD . . .

is keener in its machining methods than the U.S., or is more experienced in basing its methods on practical results.

It is therefore significant that in recent years 87% of the high-speed tool steel used in the U.S. has contained Molybdenum.

The steel has cost less, Molybdenum has been free from violent price fluctuations, and steelmakers are assured of a plentiful supply of Molybdenum.

IN GREAT BRITAIN, Molybdenum has not made the same headway — it had a set-back in war years, when some manufacturers were unfamiliar with its heat-treatment.

This, however, is simple and straightforward; Molybdenum-containing steels are bound to make still more headway.

THERE IS NO SHORTAGE OF **MOLY**

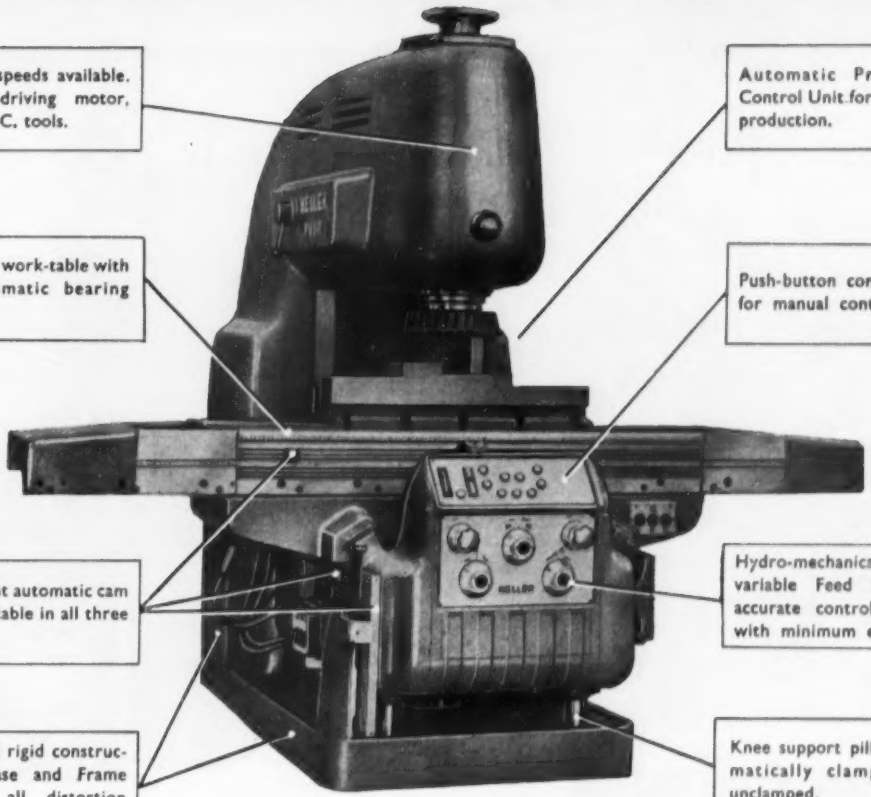
PRONOUNCED 'MOLLY'

CLIMAX MOLYBDENUM COMPANY OF EUROPE LIMITED, 99 PINSTONE STREET, SHEFFIELD, 1

HELLER

A range of milling machines with all the features you've ever wanted

TYPES 120-2 & 160



16 cutter speeds available. Powerful driving motor, ideal for T.C. tools.

Automatic Programme Control Unit for repetition production.

Large rigid work-table with wide prismatic bearing surfaces.

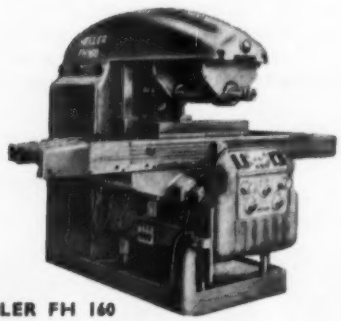
Push-button control panel for manual control.

Independent automatic cam control of table in all three directions.

Hydro-mechanical infinitely variable Feed Drive for accurate control of feed with minimum effort.

Robust and rigid construction of Base and Frame eliminates all distortion and vibration.

Knee support pillars automatically clamped and unclamped.



HELLER FH 160

Whether your production is concerned with repetition milling, batch milling, or heavy milling of individual components, here is a range of new milling machines which will interest you.

For repetition work, the operator has only to load the machine and start the automatic work cycle, which will exactly and automatically repeat all the feed movements pre-set on it.

Profile milling of batch quantities can also be carried out without operator attention, the Electro-Hydraulic Tracer Control Unit copying from a template or model in two dimensions with extreme accuracy.

Heavy milling of individual components is facilitated by the push-button control panel; this enables the operator to work within the finest limits at a high rate of production.

Write for a catalogue to-day.

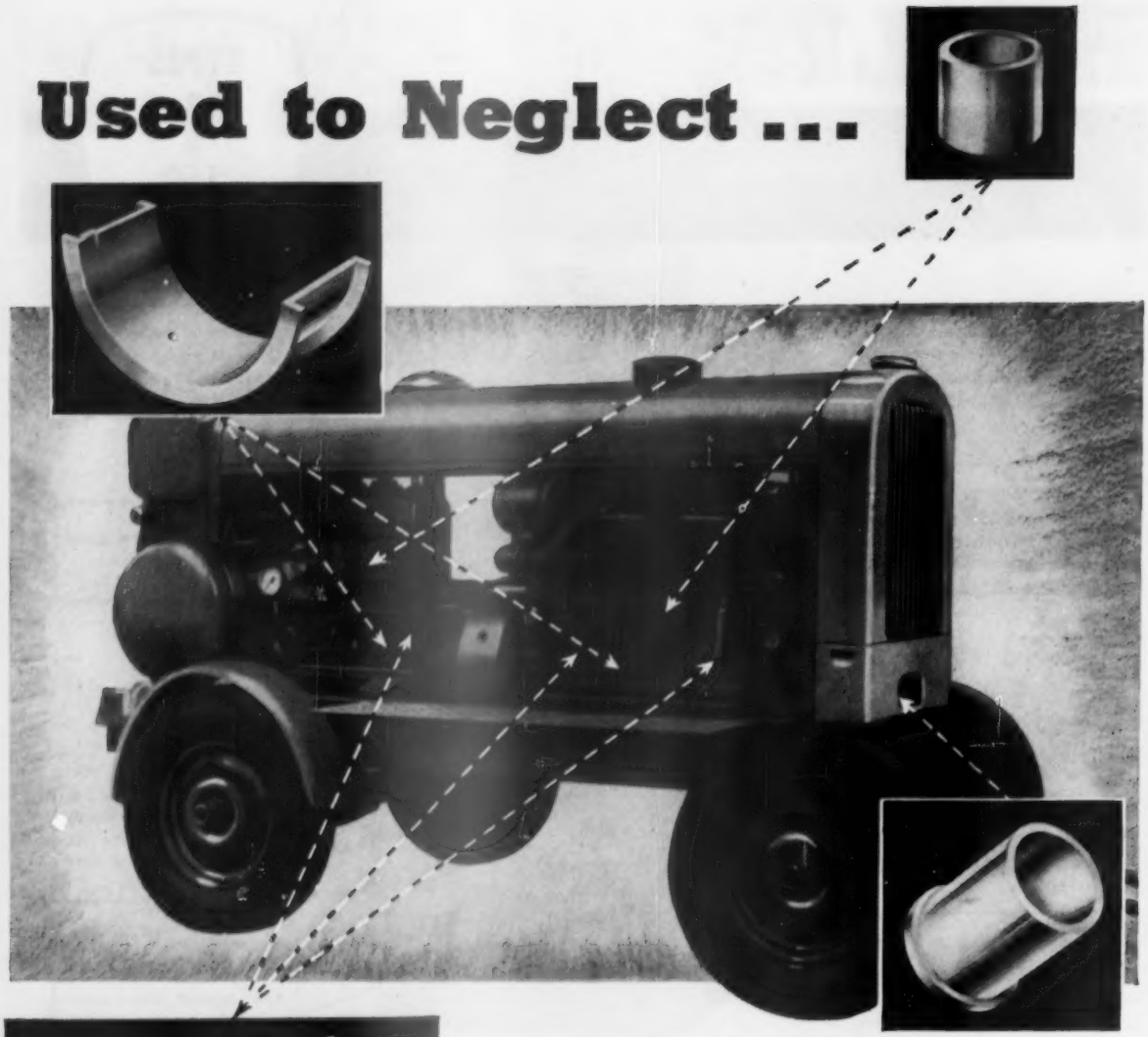
WICKMAN LIMITED

FACTORED MACHINE DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY

Telephone: Coventry 40351

398F82

Used to Neglect ...



This twin cylinder diesel compressor set will have to work at full pressure for long periods, under arduous conditions and with very little attention. The accuracy and strength of BIRSO non-ferrous castings are relied on to give unfailing service, year in, year out. Illustrated are some of the BIRSO phosphor-bronze castings used in the set, ranging from main bearing shells to connecting rod and starting-handle bushes. They are all cast to the same exacting specifications and precision-machined in our own extensive machine shops.

Our great experience and unrivalled resources, coupled with a *personal* service, are available to help solve *your* problems, too.

Castings from a few ounces to 10 *tons in phosphor-bronze, gun-metal, aluminium-bronze, manganese-bronze and light alloys. Precision-machined bushes and bearings. Specialists in high-tensile aluminium-bronze castings, centri-fugal-cast wheel blanks, and chill-cast rods and tubes.*

BIRSO TRADE MARK BN

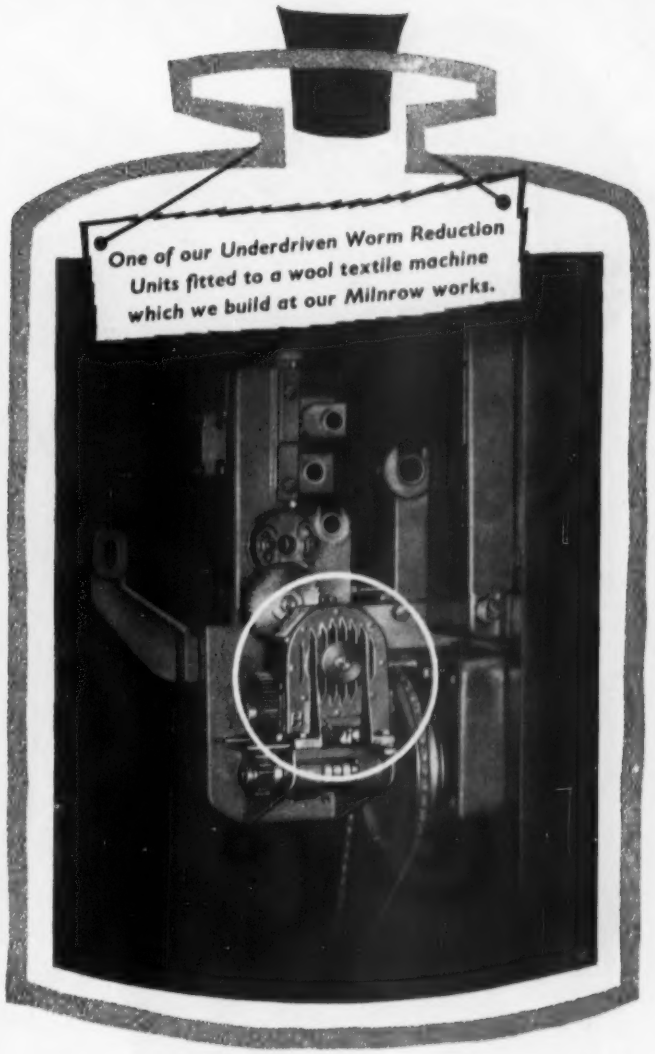
T. M. BIRKETT, BILLINGTON & NEWTON LTD.

HANLEY AND LONGPORT, STOKE-ON-TRENT

Head Office: HANLEY, STOKE-ON-TRENT *Phone: Stoke-on-Trent* 22184 LONGPORT FOUNDRY *Phone: Stoke-on-Trent* 87303

One of Britain's Largest NON-FERROUS *Foundries*

Taking our own medicine



We're as pleased as a Manchester man at a Test Match that *hasn't* been rained off. We're taking our own medicine—using our own Worm Units all over our own works. And we're liking it, because these units are doing their various jobs so very well. Which is what you'd expect from the way we make them—on special machines and from special metals, both developed by us during 50 years of Worm Gear manufacture. That's the Holroyd prescription for first-class Worm Units—

MADE UP FOR YOU IN A FEW DAYS

A Standard Type Holroyd Worm Reduction Unit with a stock ratio can be made up, packed and despatched to you within a few days. Special units or worms and wheels made to order take a bit longer. For information on our Worm Units, and on new applications for them (like the machine in the illustration) drop us a line at Milnrow, Lancs. We'll be glad to help you all we can.

Holroyd

WORM REDUCTION UNITS

JOHN HOLROYD & COMPANY LIMITED · MILNROW · LANCS · TELEPHONE: MILNROW 55399

CRC 169

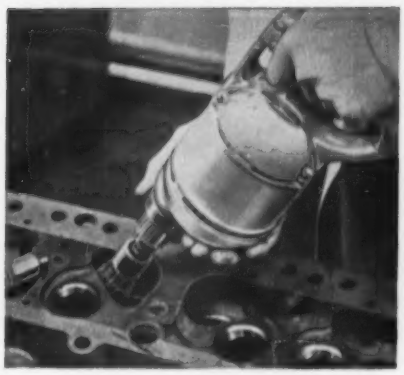
Linread technicians have always specialised in cold forging and its development. Cold forged products are stronger because the grain flow follows the shape of the finished part and there is no waste of material, while modern tool making methods ensure extreme accuracy. Special cold forgings may assist you to reduce costs or improve your product, and we are always ready to co-operate with manufacturers in the development of parts to meet their individual requirements, applying the same unsurpassed standards of quality and service as for our other products.

Linread

LINREAD LTD · COX STREET · BIRMINGHAM 3

HERE, THERE, AND EVERYWHERE...

Whenever there's a drilling job to be done . . . rely on Black & Decker Drills to do it faster, cheaper and BETTER! There are 16 models in the B & D range with capacities from ¼" to 1" in steel and double these capacities in hardwood. Use them to drive hole saws and wood augers . . . convert them into powerful drill presses with B & D drill stands. These versatile drills are used by craftsmen all over the world . . . they are part of the famous Black & Decker range which includes Saws, Sanders, Grinders & Screwdrivers.



The "½" H.D. Drill with carbon removing brush quickly removes carbon from valve ports, cylinder heads and piston tops.

B & D Drills with Hole Saws cut clean round holes in instrument panels etc.

Quicker and Better with

Black & Decker

PORTABLE ELECTRIC TOOLS

Write for catalogue. Demonstration of any tool on request.

BLACK & DECKER LTD • HARMONDSWORTH • MIDDLESEX

TOWSON, USA · TORONTO, CANADA · SYDNEY, AUSTRALIA · MEXICO, D.F · SAO PAULO, BRASIL

Smee's 2153

COMPLETE UNITS TO CUT COSTS & SPEED ASSEMBLY

SILENTBLOC-HARRIS C.P.* SPRING SHACKLES

*CONCENTRATED PRESSURE

Patent application 6907/48

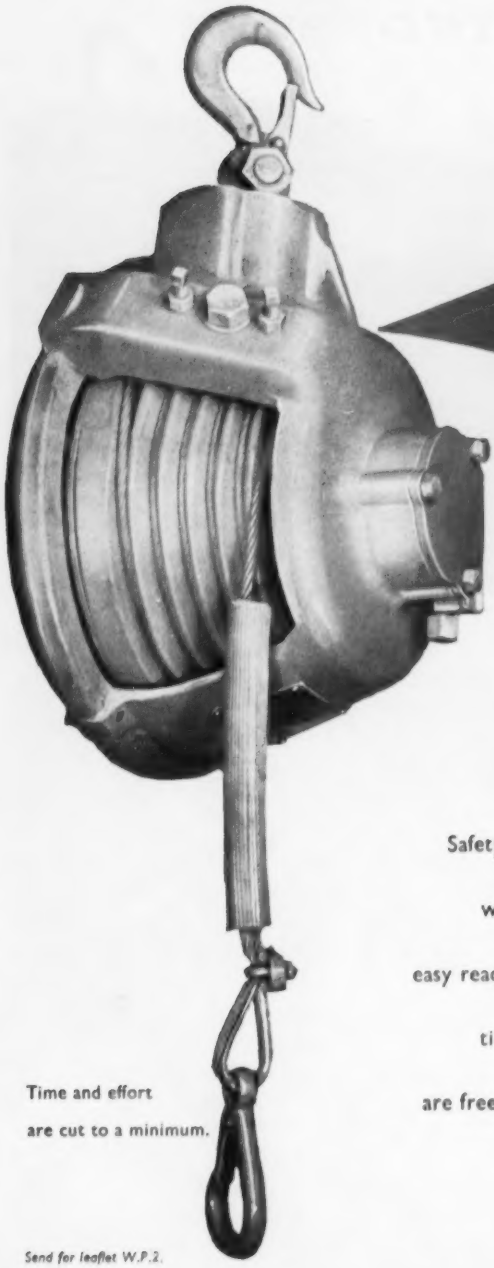
Proved in service, the Silentbloc-Harris Concentrated Pressure Spring Shackle is now a standard fitting on a number of popular production cars.

If one of the range of sizes available does not fit in with your layout we will be glad to design a complete shackle unit for you.

DESIGNERS AND MANUFACTURERS OF RESILIENT UNITS FOR MORE THAN 25 YEARS

SILENTBLOC

SILENTBLOC LTD., MANOR ROYAL, CRAWLEY, SUSSEX Tel. CRAWLEY 2100



THIS IS **the tool**

FOR INCREASED PRODUCTIVITY

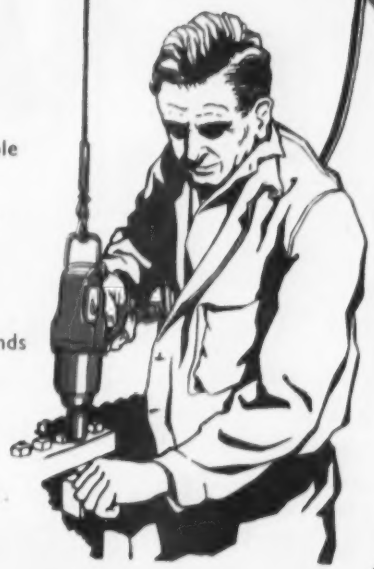
safety

balancer

SIZES 20B 30B 40B

Safety Balancers are indispensable where tools must be within easy reach of the operator. No time is wasted, and both hands are free to operate the tool.

Time and effort are cut to a minimum.



Send for leaflet W.P.2.

R27

BALANCERS
DRILLS · GRINDERS · IMPACT WRENCHES

ROTARY SANDERS · RIGHT ANGLE NUT SETTERS
RIGHT ANGLE DRILLS

ARMSTRONG WHITWORTH

Power Tools

ARMSTRONG WHITWORTH & CO (Pneumatic Tools) LTD

Main Sales Office: **40 BROADWAY WESTMINSTER LONDON SWI**
Cable Address: ARMWHITOOL SOWEST LONDON *Phone:* WHitehall 5944
Works: **TYNEMOUTH ENGLAND** ***Phone:*** **NORTH SHIELDS 3111** ***Grams:*** **ARMWHITOOL TYNEMOUTH**

1603

THE TORCH OF INDUSTRY

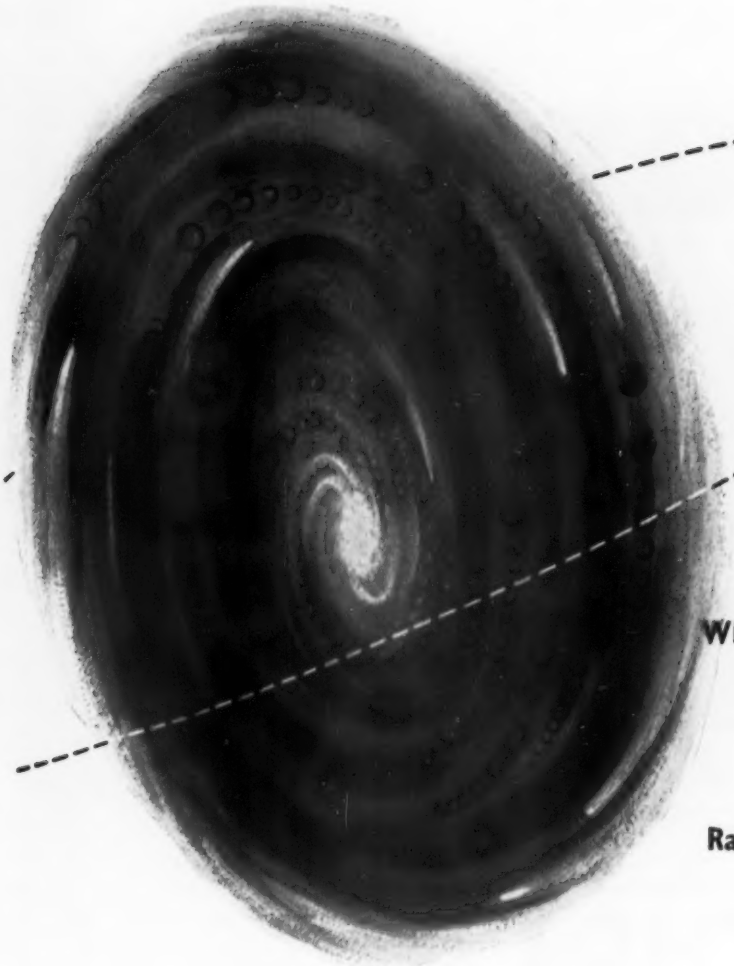
THE BEAGLE

A transportable profiler that cuts constant angle bevels automatically on curves of any radii

You can carry the Beagle — all up weight 125 lbs. — to the job and set it up to cut in a few minutes. Electrically driven and guided by a hand steered tracing wheel it will cut any profile in steel up to 2" thick, operating direct from working drawings with the greatest accuracy. No waiting for the work to come to the machine—no expensive templates needed. *And* the Beagle is fitted with a unique cutter which will maintain any bevel up to 45° round any profile.

For full details please write for the 'Beagle' leaflet to the Sales/Service Department of British Oxygen Gases Limited at Bridgewater House, St. James's, London, S.W.1.

BRITISH BOC OXYGEN



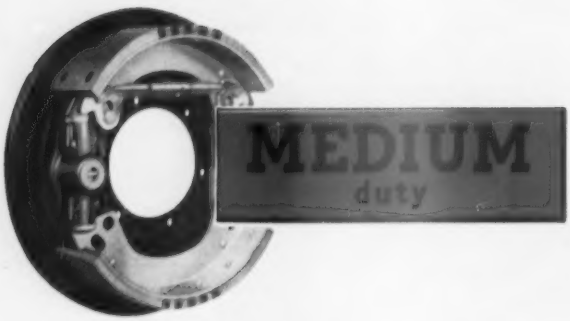
When formulating Ball and Roller Bearing mountings

submit them in confidence to our Technical Department

Ransome & Marles Bearing Co. Ltd
Newark-on-Trent, England

Please give full information and a drawing or sketch if possible:

1. Describe the machine and the exact location and/or function of the proposed bearing mounting.
2. State the speed of the rotating parts with journal and thrust loads. Say if these fluctuate and how much. Give h.p. and drive details if loads are not known.
3. Describe working conditions—temperatures, wet or dry conditions, duration of duty and any other relevant features.



For the baby car or the giant commercial transport vehicle, the Girling name means high efficiency brakes. Backed by unrivalled research and development facilities, Girling design and manufacture are geared to the production of equipment specifically designed for a specific job. For every type of motor vehicle, Girling Brakes are performing daily with the utmost reliability, always strengthening the proud claim . . .

GIRLING

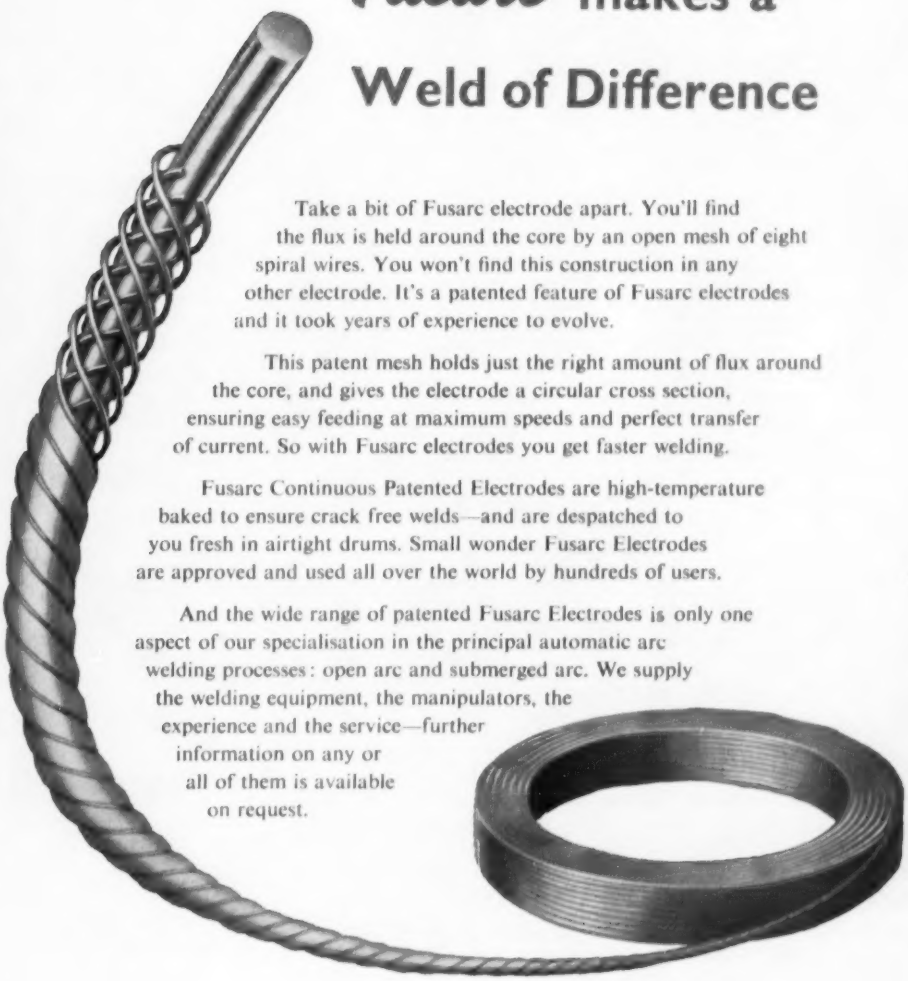
THE BEST BRAKES IN THE WORLD

WAY OUT AHEAD

GIRLING LIMITED
KINGS ROAD
BIRMINGHAM 11

When it comes to WELDING

Fusarc makes a Weld of Difference



Take a bit of Fusarc electrode apart. You'll find the flux is held around the core by an open mesh of eight spiral wires. You won't find this construction in any other electrode. It's a patented feature of Fusarc electrodes and it took years of experience to evolve.

This patent mesh holds just the right amount of flux around the core, and gives the electrode a circular cross section, ensuring easy feeding at maximum speeds and perfect transfer of current. So with Fusarc electrodes you get faster welding.

Fusarc Continuous Patented Electrodes are high-temperature baked to ensure crack free welds—and are despatched to you fresh in airtight drums. Small wonder Fusarc Electrodes are approved and used all over the world by hundreds of users.

And the wide range of patented Fusarc Electrodes is only one aspect of our specialisation in the principal automatic arc welding processes: open arc and submerged arc. We supply the welding equipment, the manipulators, the experience and the service—further information on any or all of them is available on request.

This comprehensive welding service combines the team work of The Quasi-Arc Co. Limited (including the famous Sigma welding process) plus *Fusarc Limited which incorporates Unionmelt—the world renowned submerged arc process.*

Come to QUASI-ARC

QUASI-ARC LIMITED · BILSTON · STAFFORDSHIRE

*Formula for*_____ STEEL

The "quality" of a steel depends on the accuracy of its chemical composition and its freedom from inclusions and impurities. Vacuum melting of metals therefore ensures the highest "quality" as there are no melting losses, no oxidation of the melt and no necessity for slags which can result in entrapped inclusions.

At Jessops today, vacuum melting is used only in the laboratory to ensure the best "quality" in experimental alloys but as a result of this work not only are new and improved materials being studied but the way is being paved for the production of vacuum melted alloys in the future.

The furnace shown can melt 20 lbs. of steel under a vacuum of 0.0001 mm. of mercury, which is a ten millionth of atmospheric pressure. Alloys melted in this way are generally easier to fabricate and may have improved physical and mechanical properties.

This is the twelfth in a series of illustrations of highly specialised equipment devised to control the production and testing of special steels by William Jessop & Sons Ltd.

WILLIAM JESSOP & SONS LTD

Founded 1774

STEELMAKERS, SHEFFIELD

WESTON
IMPAX
SEALS

LOW FRICTION AT HIGH SPEED & HIGH TEMPERATURE

The Weston Impax Seal provides an efficient face type gland for rotating shafts running at high speeds coupled with high fluid temperatures and pressures. Where equipment has to be the BEST it DESERVES Weston Impax Seals.

Write for a fully descriptive brochure

W

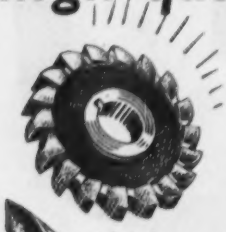
CHARLES WESTON & CO. LIMITED
Irwell Bank Works · Douglas Green · Pendleton · Salford 6
Telephone: Pendleton 2857-8-9; Birmingham: Midland 6952; London: Holborn 0414

...Who serve you well!

B.S.A ids to Production

TRADE MARKS B.S.A

high quality tools for all classes of work

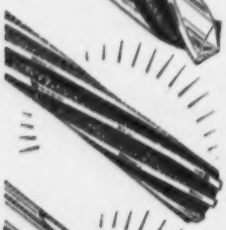


MILLING CUTTERS

An extremely wide range. H.S.S. (and Cast, at lower cost). All the most generally used sizes and types. Super-cut, for heavy-duty milling, have specially designed teeth for extra strength. Form relieved and special cutters supplied.

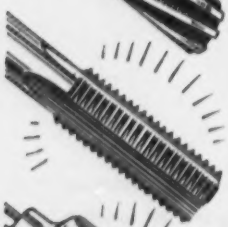
TWIST DRILLS

Specially treated for long-life. Materials of only the highest grade are used in their manufacture. B.S.A. drills definitely reduce hole costs. H.S.S., Carbon steel, and special types for various materials.



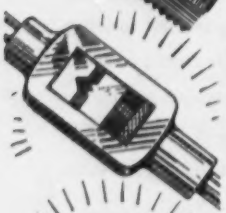
REAMERS

All standard types and sizes available in H.S.S., including counterbores, adjustable reamers, shell reamers and arbors. Specialities include a Super-finish reamer for heat-treated steels, and a combined drill-reamer—a real time saver.



TAPS

A complete coverage of standard H.S.S. ground thread, and carbon steel cut-thread and ground-thread. Sizes and types outside the usual range can be supplied, including taps with spiral points or spiral flutes, at special prices.

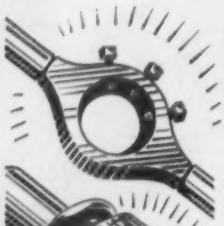


TAP WRENCHES

These are of the adjustable type, Nos. 1 to 4, covering taps from $\frac{1}{16}$in. to 1$\frac{1}{4}$in. and Services type B.B.: $\frac{1}{8}$in. to 1in., C.C.: $\frac{1}{4}$in. to $\frac{3}{8}$in. Carefully treated, well finished, extremely durable.

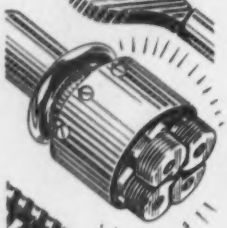
SCREWING DIES

Carbon steel, circular adjustable type: plain, parallel and taper, for British and American threads and Metric sizes. Also a complete range of carbon steel hexagon die nuts. Of consistent quality and uniformity.



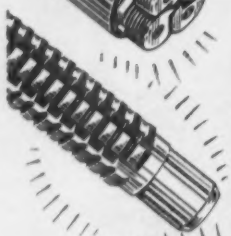
DIE STOCKS

For circular dies from $\frac{11}{16}$in. to 2$\frac{1}{4}$in. dia. Made to the same high standards as other items in the B.S.A. range of screwing equipment. Also screwing sets, thread rolling dies, tap extractors and—



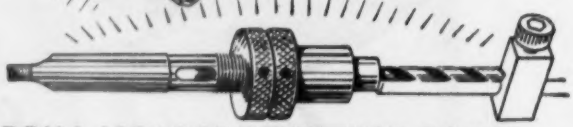
DIEHEADS

B.S.A. NAMCO—simple in construction, easy to adjust. Circular chasers ensure extreme accuracy of thread form and long life. They can be ground and re-ground through a full 270 degrees of their circumference.



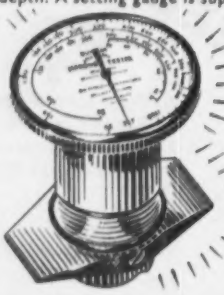
BROACHES

Scientifically processed for extra performance. B.S.A. Tools' Broach Division has the capacity and ability for designing and manufacturing every size and type of broach, each to the highest standards of precision and endurance.



DRILL HOLDER & SETTING GAUGE

For accurate drilling to pre-set depths. Safe and simple to use. Accommodates any size of drill, reamer or tool with a standard M.T. shank. The distance between the drill point and the lower face of the bush (which is screwed along the body then locked in position) establishes the required depth. A setting gauge is supplied to facilitate quick and accurate setting.



PORTABLE HARDNESS TESTER

A lightweight, accurate, universal, direct-reading hardness tester. V.P.N., Brinell and Rockwell 'C' hardness values (B.S.I. 860) are marked in contrasting colours on its large easily-read dial. Pressure on the grip lowers the diamond indentor to the test piece. Further pressure causes the hardness value to be registered. Penetration in soft metal is only 0.005in. Supplied in a handsome case complete with servicing kit.

ALSO SCREWING SETS · DRILL CHUCKS · MACHINE VICES · MILLING MACHINE ARBORS · OIL & SUDS PUMPS · LIMIT SWITCHES

B.S.A. TOOLS LTD., BIRMINGHAM, ENGLAND

Sole Agents Great Britain:

BURTON GRIFFITHS & COMPANY LIMITED

Small Tools Division: Montgomery Street, Birmingham, 11. Tel: VICTORIA 2351 (9 lines)

BURTON GRIFFITHS

HOFFMANN
BALL AND ROLLER
BEARINGS
ON QUALITY
STANDARD EQUIPMENT ON MOST
OF BRITAIN'S MOTOR CARS
THE HOFFMANN MANUFACTURING CO. LTD. CHELMSFORD, ESSEX.

A TURN TO THE RIGHT . . .

At the next corner, or the next-but-one, our lady driver will turn to the right (or will it be the left?) taking steel with her in a multitude of forms. Body work, chassis, engine, the wheel she holds, the foot pedals she sometimes uses and many other components are made from steel—more often than not, Steel by LEE. Our daily output of cold rolled strip, bright drawn bars and "Trubrite" stainless steel feed the production lines of leading automobile, motor cycle, and bicycle manufacturers. Limited only by the fields in which steel is used, LEE'S products feature extensively in well-known domestic appliances, cutlery, and kitchen equipment manufacture, shipbuilding yards and aircraft plants, etc., to name but a few. A word about steel with LEE of SHEFFIELD will be a turn to the right.

LEE *of Sheffield*

TRUBRITE

ARTHUR LEE & SONS LIMITED

HEAD OFFICE AND WORKS: TRUBRITE STEEL WORKS · MEADOW HALL · NEAR SHEFFIELD

For all the best engines

PISTONS
PISTON RINGS
CYLINDER LINERS
VALVE SEAT INSERTS
VALVE GUIDES
TAPPETS ETC.

QUALITY PAYS!

THE BRITISH PISTON RING CO., LTD., HOLBROOK LANE, COVENTRY

Cogent

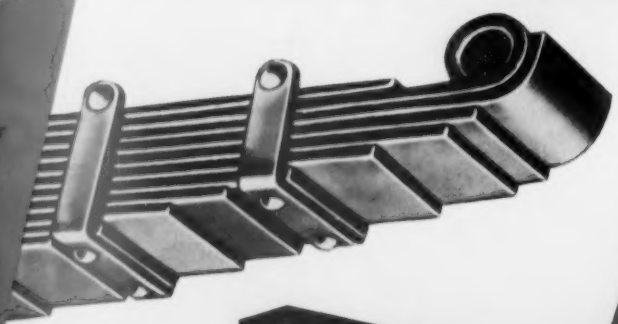
TOLEDO WOODHEAD

make them all

TORSION BARS

COIL SPRINGS

Coil, laminated and torsion bar springs are manufactured by Toledo Woodhead for every type of automotive vehicle — with shot blast treatment for longer fatigue life if required. We also supply Tine springs for cultivator and agricultural implement manufacture.



LAMINATED SPRINGS

We are also the manufacturers of KANTLINK SPRING WASHERS

TOLEDO WOODHEAD SPRINGS LIMITED · SHEFFIELD 3

TWS52

Proved in Service

Largest in the David Brown range, the 557 CM 5-speed Gearbox has proved itself as a completely dependable unit by the large numbers giving world wide trouble-free service, often under really tough operating conditions.

Outstanding features include:—

- **Constant mesh gears for all speeds including reverse, ensuring long life and quiet running.**
- **Alternative standard ratios giving direct or over-drive top gear**
- **Sturdy, simple and compact design, having low weight to strength ratio.**
- **Gear shafts located in horizontal plane, permitting shallow case.**
- **Upper half can be removed without disturbing gears or selector mechanism.**
- **Compact forward control unit, connected to gearbox by two universal joints offering flexibility of chassis layout.**

Specification E.393.19, giving complete details, is available on request.

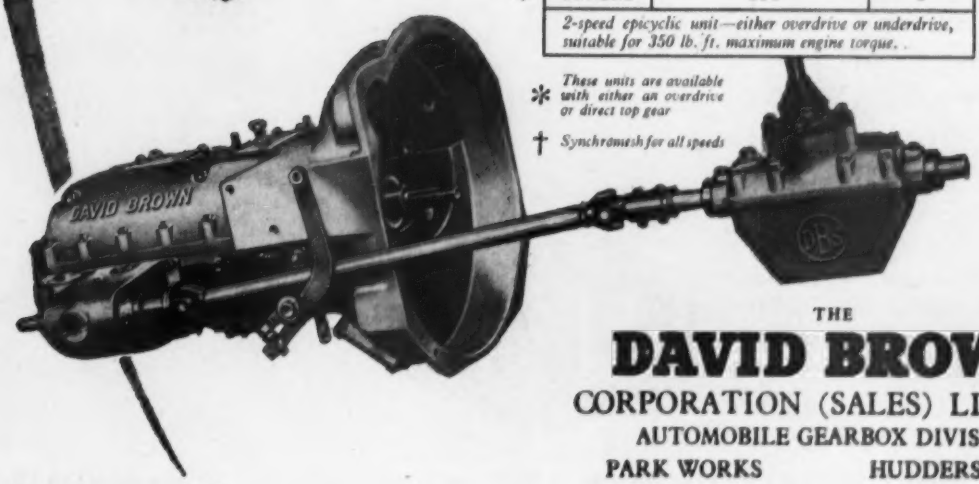
STANDARD GEARBOX RANGE

	Type	Max. Engine Torque (lb/ft)	No. of Speeds
	430C	90	4
	437	133	4
✻	542	205	5
✻	45	250	5
✻	045	250	5
†	S450	300	4
✻	557CM	350	5

2-speed epicyclic unit—either overdrive or underdrive, suitable for 350 lb. ft. maximum engine torque.

✻ *These units are available with either an overdrive or direct top gear*

† *Synchromesh for all speeds*



THE

DAVID BROWN

CORPORATION (SALES) LIMITED

AUTOMOBILE GEARBOX DIVISION

PARK WORKS HUDDERSFIELD

WHEN RELIABILITY MEANS SO MUCH . . .

P·B·M CASTINGS ARE USED

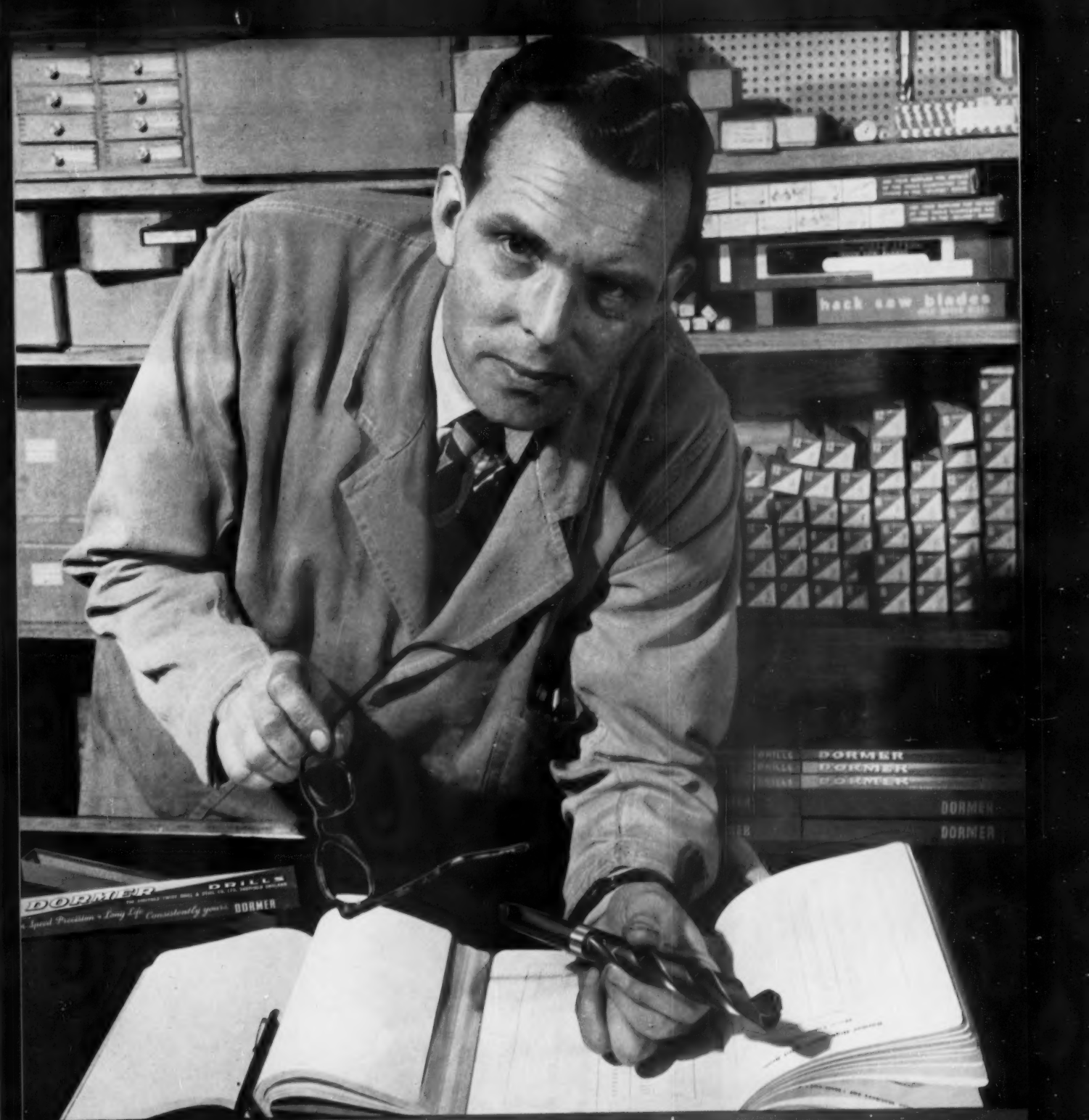
For the remarkably successful 'Leonides' Helicopter Engine, Perry Barr Metal provides a highly important component in the form of an Aluminium Casting for the Rotor Clutch Assembly. This is just another example of P.B.M. workmanship in the highest class of Aero Engineering

GRAVITY DIECASTINGS
MACHINED CASTINGS
AND ASSEMBLIES

P.B.M. have excellent facilities for supplying castings as fully machined and assembled components—we invite your enquiries

PERRY BARR METAL COMPANY LTD., GREAT BARR, BIRMINGHAM 22A

TELEPHONE: GREAT BARR 1794-5-6



I sell DORMER tools without any trouble...

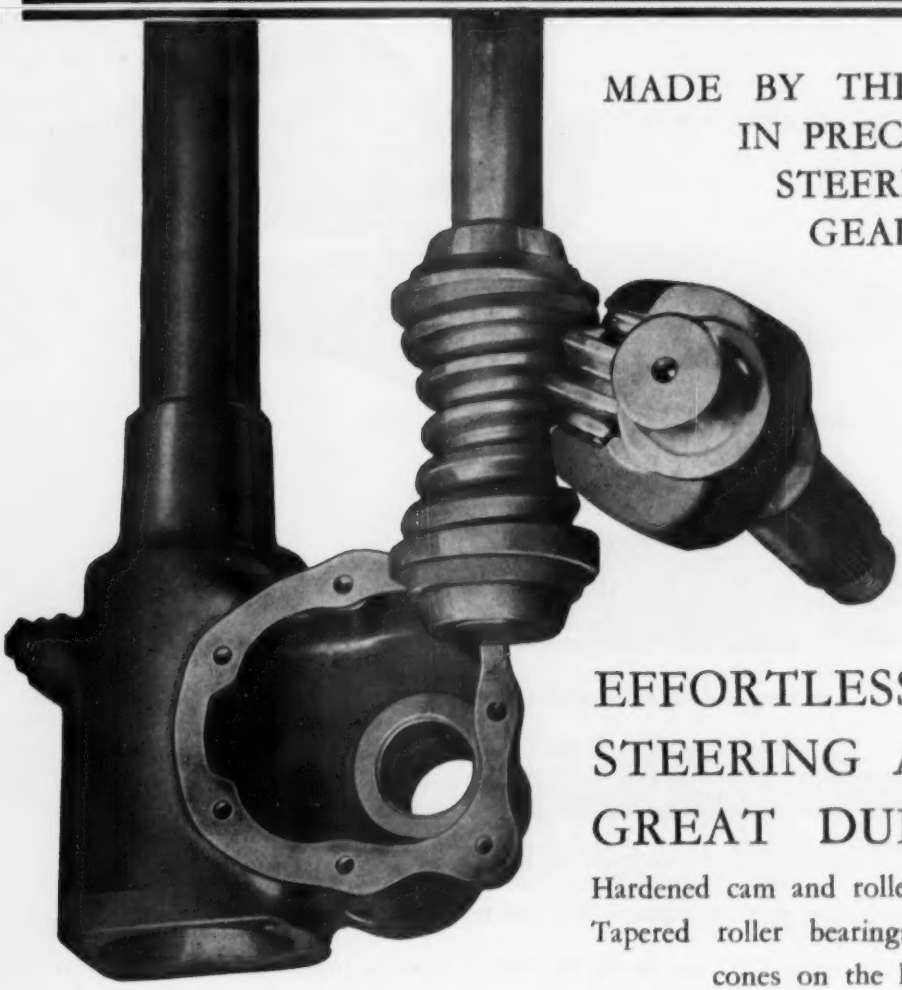
THE SHEFFIELD TWIST DRILL AND STEEL COMPANY LIMITED
SHEFFIELD ENGLAND

DORMER TOOLS ARE OBTAINABLE FROM YOUR USUAL ENGINEERS' MERCHANTS

Excellent deliveries
Constant demand
Highly satisfied customers

THAT'S WHY I REPEAT
DORMER

Engineered rubber as a silent partner
EMPIRE RUBBER COMPANY | RUBBER BONDERS LTD
DUNSTABLE, BEDFORDSHIRE, ENGLAND



MADE BY THE PIONEERS
IN PRECISION
STEERING
GEARS

EFFORTLESS STEERING AND GREAT DURABILITY

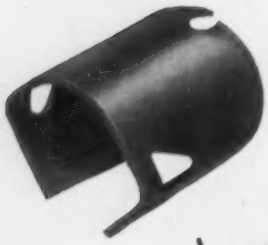
Hardened cam and roller.
Tapered roller bearings (with detachable cones on the larger sizes).
Double bearing support to rocker shaft.
End-location adjustable.
Larger angular movement.
Very compact box.
For fore-and-aft or transverse layout.
Trunnion or spigot mounting alternative on heavy types.

THE 'MARLES' DOUBLE-ROLLER GEAR, made in a range of sizes covering every type of chassis.

BETTER ROADS
FOR
BETTER LIVING

MARLES

ADAMANT
ENGINEERING CO. LTD., DALLOW ROAD, LUTON
Sole proprietors of the Marles Steering Company Ltd.
Telephone: LUTON 2662 (4 *lines*). *Telegrams:* ADAMANT, PHONE, LUTON



that's fixed that!

101 Spire speed nuts are used in the Ford Anglia. Compared with conventional bolt and nut methods which involve welding, riveting and threaded inserts, Spire parts speed up the assembly enormously—especially in blind locations. They hold fast under vibration and save a good deal of weight.

There are over 200 different types of Spire fasteners. Here are the main types used on the Ford Anglia :— SNJ nuts retain the front wings and grille casing; SNU nuts secure the window channels, instrument cluster and sun vizor; SNO nuts fix grille bars to grille casing, and head lamps and parking lamp bezels to front wings; SFP fixes fasten the lamp lenses; SFR fixes and SCL clips retain the badges and moulding. All these jobs, and many others besides, can be done quicker, cheaper and better by Spire.

SPEED NUTS—FASTEST THINGS IN FASTENINGS

Spire

Enquiries to:

SIMMONDS AEROCESSORIES LTD.

Byron House, 7-8-9 St. James's Street, London, S.W.1.

Head Office and Works: Treforest, Pontypridd, Glamorgan.

Also BIRMINGHAM, STOCKHOLM, COPENHAGEN, MELBOURNE, SYDNEY, JOHANNESBURG, AMSTERDAM, MILAN & NEW YORK

A MEMBER OF THE FIRTH CLEVELAND GROUP

CRG 406

An announcement by
BIRLEC LIMITED
Member of the A.E.I.
Group of Companies

Leadership in melting

BIRLEC LIMITED

are pleased to announce an arrangement with

OTTO JUNKER GMBH

of Lammersdorf, Germany, and the

AJAX ENGINEERING CORPORATION

of Trenton, U.S.A.

for the development and marketing of the

MAINS FREQUENCY CORELESS INDUCTION MELTING FURNACE

The addition of this furnace, already well proved in both ferrous and non-ferrous fields, enlarges still further the extensive range of Birlec melting equipment, thus maintaining—

BIRLEC

Birlec leadership in melting

SM/B2612/55

PARK GATE

QUALITY STEELS
FOR THE MOTOR INDUSTRY

1825 EXPERIENTIA DOCET 1955

case hardening quality

for

gudgeon pins

THE PARK GATE IRON & STEEL CO. LTD., ROTHERHAM

TELEPHONE : ROTHERHAM 2141 (10 lines) TELEGRAMS : YORKSHIRE, PARKGATE, YORKS

GACO
'O' RINGS
GEORGE ANGUS & Co LTD
OIL SEAL DIVISION
NEWCASTLE UPON TYNE, 6.
GACO

On-the-spot service
LUTON
Luton, home of the Skefko Ball Bearing Company, has long been recognised as one of Britain's most thriving industrial towns. The rapid development of the automobile industry and many other branches of light engineering in this area, is reflected in the continual expansion of Skefko, whose works in Luton are among the most modern bearing manufacturing plants in the world
LEAGRAVE ROAD, LUTON
Tel: Luton 5700 (14 lines) Grams: Skefko, Telex, Luton
SKF
BALL & ROLLER BEARINGS
THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS
THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

One of a series of advertisements featuring the main towns where SKF service is centred. Other SKF offices are at:—ABERDEEN · BELFAST · BIRMINGHAM · BRISTOL · CARDIFF · DUBLIN · EDINBURGH · EXETER · GLASGOW · LEEDS · LEICESTER · LIVERPOOL · LONDON · MANCHESTER · NEWCASTLE-ON-TYNE · NOTTINGHAM · SHEFFIELD · SOUTHAMPTON G132

AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

Editor: J. B. DUNCAN

Editorial Staff: T. K. GARRETT, A.M.I.Mech.E., A.F.R.Ae.S.(*Associate Editor*), F. C. SHEFFIELD

Publishers: ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1.
Telegrams: Sliderule, Sedist London **Telephone: Waterloo 3333 (60 lines)**

COVENTRY:	BIRMINGHAM, 2:	MANCHESTER, 3:	GLASGOW, C.2:
8-10, CORPORATION ST.	KING EDWARD HOUSE, NEW ST.	260, DEANSGATE	26B, RENFIELD ST.
Telegrams: Autocar, Coventry	*Telegrams:* Autopress, Birmingham	*Telegrams:* Iliffe, Manchester	*Telegrams:* Iliffe, Glasgow
Telephone: Coventry 5210	*Telephone:* MIDland 7191-7	*Telephone:* Blackfriars 4412	*Telephone:* Central 1265-1266 (2 lines)

PUBLISHED MONTHLY—SECOND WEDNESDAY. ESTABLISHED 1910

Annual Subscription: Home and Overseas £2 11s. 6d., including the Special Number; Canada $7.50; U.S.A. $8.00

VOL. 45 No. 11 NOVEMBER, 1955 PRICE 3s. 6D.

Reaction of Production on Design

MANY different and sometimes conflicting factors must be weighed in seeking to determine how far the British automobile industry can afford to go in the employment of the new production techniques now common in the United States of America. Production engineers will say that attempts should be made to surpass American practice; and they can advance cogent reasons to support this contention.

Machines specially designed to carry out automatically a complete sequence of operations on one specific part, and more particularly on a part calling for many operations, will give a high hourly output for a lower capital outlay than would be necessary if standard individual machines were used. They will also give a lower direct labour cost per unit; will lower certain overhead charges inasmuch as the output can be produced in a smaller factory area; and according to Renault experience maintenance charges will be reduced. If these were the only factors to be considered, the production engineer's case for the wider use of even more complex fully automatic transfer machines would be unanswerable.

There are, however, other, not unimportant, factors. Will the introduction of these complex and expensive machines tend to freeze design development? The more a machine is designed to work on one specific unit, the less flexible it is. Individual standard machines can be adapted fairly easily to accommodate radical changes in design, whereas special purpose machines cannot. With such machines, major design changes in the components produced can be justified only if they bring major improvements in their train.

In some respects, amortization charges are the crux of the matter. Obviously, a very large total output of a single design is necessary if the charge per unit is to be low. A superficial comparison of British and American outputs would suggest that the industry in this country cannot afford to follow American practice, particularly that employed in the production of Chevrolet and Ford cars. In 1954 the output of each of these cars was in the region of 1,400,000. The highest British output of one model is about one-twelfth of that figure, which immediately suggests that amortization charges would be twelve times as great. This, however, disregards the fact that the output in this country is obtained from what may be regarded as a single machine line, while a multiplicity of lines is required for the American output.

A cylinder block is probably the most suitable component to consider in making a comparison of this character. The highest production figure yet obtained from a single line in America is 100 blocks per hour; the highest in this country is about 50 per hour. Therefore, for the same life currency of an engine design in terms of years, amortization charges in this country would be roughly double those for the most efficient American machine. Amortization charges for units of stabilized design are not an insuperable bar to the introduction of even more complex and more expensive transfer machines.

The position is very different for units that are likely to be subject to radical changes in design. Transmissions are a case in point. Automatic transmissions are already here for the more expensive cars, and before long they will be introduced, in one form or another, for the less expensive cars.

To produce an automatic transmission, i.e., one of the types current in the U.S.A., at a price that will be a reasonable proportion of the total price of a vehicle in the medium price range, will not be easy. While the designer's primary concern will be the functioning of the unit, very close attention will have to be given to ease of production; and it may be difficult to reconcile design for functioning with design for production.

One thing is certain: a low cost level will be possible only if there is very large output by the most advanced production techniques. It will be more than ever necessary to ensure that the design is absolutely correct, before production is undertaken; "nearly right" will no longer do.

Frankfurt Show

THAT British manufacturers are not alone in studying commercial vehicle suspension systems with a view to obtaining a better ride than that experienced with current designs was made clear at the Frankfurt Show. There, a large variety of suspension layouts was displayed. It is, however, doubtful if all have been fully proved: rather it would appear that many of the manufacturers have been forced, by competition, into a premature display of designs that are still not fully developed.

Nevertheless, some of the examples of bus and coach suspensions that were shown have been well tested and give not only a marked improvement in ride, but also do not lead to undue tyre wear. Short road tests on vehicles

with different types of suspension showed that undoubtedly the best results are obtained with independent suspension at the front and rear. In fact, provided the tendency to excessive pitching can be countered, the ride with this arrangement may be even better than that of private cars: this is due to the high ratio of sprung to unsprung mass of public service vehicles, and to their relatively large weight, which makes them steadier.

Because independent suspension involves the use of single instead of double wheel equipment, most manufacturers employ this system only at the front. This enables them to use twin wheels at the rear and so avoid restriction on the load-carrying capacity of the vehicle. Nevertheless, in some instances coil springs instead of semi-elliptic springs are employed in conjunction with the twin wheels and conventional axle at the rear. The advantage of the coil spring arrangement is that it is smoother in action than the semi-elliptic type of spring, with which interleaf friction tends to transmit shocks to the frame. A disadvantage, of course, is that when coil springs are employed, additional linkage has to be incorporated to locate the axle.

In some designs, coil springs are used in conjunction with a beam axle for the front suspension. The slight improvement in ride and stability obtained with this arrangement scarcely seems to justify the additional cost. Rather would it appear that the even greater cost of independent front suspension gives a more worthwhile return in terms of passenger comfort, stability, reduced fatigue loading of the vehicle and weight reduction. Surprisingly, some manufacturers state that improved tyre wear has been obtained with double transverse wishbone link type front suspension systems than with beam axle and coil spring arrangements. However, this may be due to shortcomings in respect of the mounting of the beam axle system rather than to inherent advantages of the independent suspension layout.

Frames and Structures

The trend towards the employment of aluminium for coaches and commercial vehicles in general is not so marked in Germany as in many other countries. Although the best results, so far as weight saving is concerned, can be obtained with truly chassisless construction, many manufacturers have adopted the semi-chassisless form of design. Probably this is because a chassis with a light underframe can be made self-supporting and easily handled in the factory; furthermore, it can be delivered readily under its own power to the bodybuilder or to the quayside for export. Another advantage is that this type of construction lends itself well to adaptation for bodies other than buses and coaches.

The expense of air conditioning, that is, refrigeration and humidity control, as well as heating and ventilation, is scarcely justified in the British Isles. The attention that German manufacturers are devoting to this subject is an indication of their increasing efforts to enter export markets.

Although only one coach shown at Frankfurt was equipped with refrigeration and humidity control plant, most exhibits incorporated well designed heating and ventilation systems. Some manufacturers favour the oil-burning type of heater and others the engine coolant operated system. All are devoting considerable attention to the provision of adequate ventilation without draughts. Three or four small ventilators in the roof are not adequate for public service vehicles. An important fundamental requirement is that the area of the air intakes shall be large enough to pass an adequate volume of air, preferably without the use of a fan.

Good results have been obtained by having the air intakes under a forward projection of the canopy over the windscreen head-rail. When the vehicle is in motion, the air pressure in this position is relatively high, so large volumes of air are forced through the ducts even when the vehicle is travelling slowly.

Engines and transmissions

Hitherto, in Germany, the rear-engine layout has been preferred to the underfloor arrangement for buses and coaches. There are signs, however, that underfloor engines are becoming more popular. Although noise and fumes are more easily kept out of the coach when the engine is at the rear, the underfloor arrangement has the advantage that it enables a more even distribution of weight between the front and rear axles to be obtained. This has become a factor of major importance, because of the impending reductions in permissible axle loads in Germany. A disadvantage of the rear-engine layout, particularly if a high degree of noise reduction has been obtained, is that the driver cannot hear the engine and therefore cannot have such good control over it.

There was nothing new to be learned at Frankfurt about transmissions. The ultimate aim is at two-pedal control, and British manufacturers are still to the fore in this field. There are, however, one or two interesting methods of pre-selection. For example, Henschel and Sohn G.m.b.H., have developed a device whereby, after the gears in a two-speed auxiliary train have been pre-selected, final selection is made simply by relaxing for an instant the pressure on the throttle pedal. Movement of the pre-selection control simply compresses a spring in the change-speed linkage, but the gear shift cannot be effected while the drive is being transmitted. When the drive torque is relieved, the spring effects the change. Another vehicle, the Pekol bus, has an indicator on the dash to show which gear is in operation and which is pre-selected.

CONTENTS

	Page
Editorials — Reaction of Production on Design. Frankfurt Show	445-446
German Public Service Vehicles — A Review of Some Current Designs and Trends	447-459
Testing Internal Hardness — Emco-Intest Instruments Adaptable to Bores of Differing Diameter and Length	460
Cylinder Liner Production — The Procedure Employed by Sheepbridge Stokes Ltd., to Ensure High Quality	461-466
The Fiat 600 — Part II: Details of the Mechanical Components of the Chassis	467-478
Weldalloy Truck Bodies — All-welded Light Alloy Structures of Minimum Weight	479-482
Current Patents	483-484

GERMAN PUBLIC SERVICE VEHICLES

A Review of Some Current Designs and Trends

UNDOUBTEDLY an outstanding feature of the 1955 Frankfurt Show was the improved suspension systems for buses and coaches. Nevertheless, it seems likely that the pressure of competition has forced some manufacturers to exhibit vehicles, with new types of suspension system, which are not yet fully developed, and that they may have difficulties still to be overcome. There were several vehicles with unequal length, double transverse wishbone link type systems at the front and either a semi-elliptic or coil spring arrangement with a conventional axle at the rear, and at least two vehicles had independent suspension of the double transverse wishbone link type, both at the front and rear. In some of the buses and coaches shown, the beam axle front suspension layout has been retained, but coil instead of leaf springs are employed. However, this arrangement involves the use of some form of linkage to locate the axle, and this is a relatively high price to pay for the slight advantages that the coil type of spring has over the leaf spring. These advantages, of course, are light weight and almost complete freedom from friction. In most instances the location of the beam axle is effected by a trailing link, of V- or A-form, used in conjunction with a Panhard rod.

Short road tests of several vehicles indicated that those fitted with independent suspension both at the front and rear can give a ride that is superior even to that of private cars. This undoubtedly is because of the greater weight and, therefore, steadiness of buses or coaches, and also to the relatively high ratio of sprung to unsprung weight. There can be but little doubt that when a proportion of the general public has had experience of the comfort offered by all-round independent suspension, any lower standard will become unacceptable. Thus, it seems likely that when one manufacturer is in a position to produce vehicles of this type in relatively large numbers, the others will have no option but to follow suit, or at least to offer something that does not fall far short of this standard. An obvious alternative is independent front suspension with conventional or perhaps coil spring type suspension at the rear.

Reports indicate that with some of the independent suspension systems tyre wear is even better than that obtained with conventional semi-elliptic spring layouts. There were also suggestions that tyre wear with one of the beam axle and coil spring layouts was proving to be a problem. An examination of the layout in question indicated that there might be some truth in this. A problem that has to be solved with independent suspension all round is the avoidance of low frequency pitching. This would appear to be largely a question of adopting a suitable k^2/ab ratio, where k is the radius of gyration and a and b are the distances between the centre of gravity and the front and rear axles respectively. Since the wheelbase is limited by legal requirements, this ratio can only be reduced by keeping the floor as low as possible and limiting the overhang at the front and rear ends. If the front and rear overhangs have to be reduced, the passenger-carrying capacity will also be restricted, so this arrangement might be practicable only for certain classes of luxury coach. In any case, it is obvious that the vehicle must be designed for the suspension rather than the suspension applied to an existing design of vehicle.

Another feature of many of the German vehicles is low weight. There are a number of buses and coaches that weigh twice as much in the laden as in the unladen condition: in fact, this ratio of 2:1 is exceeded in some instances. Weight reduction has been obtained both by the employment of aluminium alloy chassisless construction and also as a result of the incorporation of independent suspension. Not only are the independent suspension units themselves of lighter weight than the more conventional arrangement, but, in addition, the structure does not have to be so sturdy, since the shock and fatigue loading on it are appreciably reduced. The influence of the aircraft industry is readily discernible in many of the structural designs. This, of course, is because of the transfer, since the end of the war, of engineers from the aircraft to the motor industry.

Although the lightest of the designs are of the chassisless type, there is a strong case for the employment of semi-chassisless construction. With this form of construction, the light underframe that is employed is not, by itself, adequate to take the full load of the vehicle, since the structure is not complete until the body has been built on to the underframe. The advantage of this arrangement is that the mechanical components of the chassis are

The Pekol bus, exhibited by Kässbohrer, has independent suspension at the front and rear

mounted in a self-contained unit that can be driven away to different coach-builders and can also be readily handled on the manufacturer's premises. Moreover, chassis of this type can be employed for bodies of vehicles other than buses or coaches. Operators transporting relatively fragile goods undoubtedly would view with favour a vehicle, such as a pantechnicon, for example, with the good suspension characteristics of modern coach chassis.

The disadvantage of the arrangement is that it is not so light as chassisless construction. This is mainly because longitudinal members have to be incorporated in the basic frame. With chassisless construction it is generally possible for the side panels of the vehicle to act as the main longitudinal members. In a number of the semi-chassisless frames exhibited, the longitudinal members were exceptionally deep and of thin gauge steel.

Although light alloy is used in some buses and coaches, the majority are still of steel construction. This is largely because aluminium alloy costs about 5 marks per kg, whereas steel costs only 90 pfennigs. When comparing these prices it is, of course, necessary to take into consideration the fact that the density of aluminium is only about one-third that of steel, so these prices per kg are not a true indication of price per unit of quantity, for instance, in terms of area of sheet. It is generally considered that if the price of aluminium could be reduced to about 3·75 marks per kg, more vehicles would be built of this material than of steel. Riveted construction is still widely used with aluminium, although there are signs of increasing interest in welding techniques, which have recently been considerably improved.

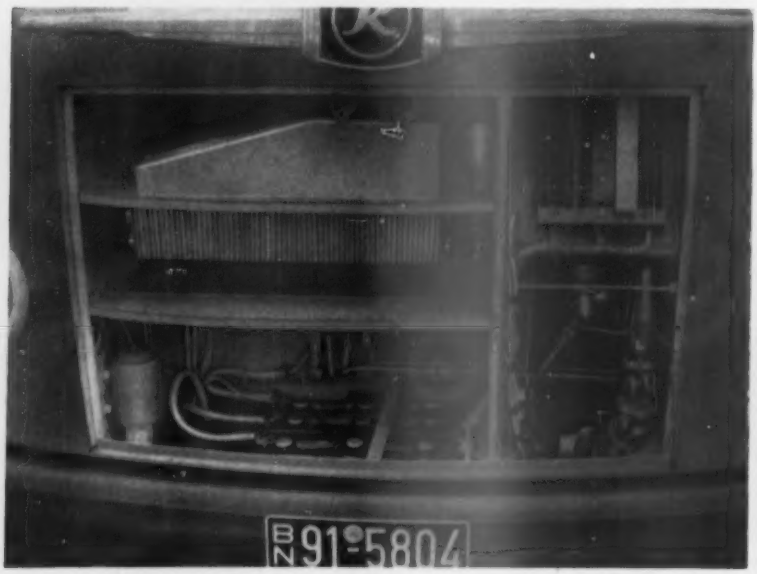
The trend towards lightweight construction is partly inspired by the impending changes in the regulations regarding the permissible weights per axle and overall length of vehicles. There is also the economic incentive, which has already led manufacturers in Britain to reduce unladen weights on the one hand and to increase the passenger-carrying capacity on the other. At present, the limit in Germany is 10 metric tonnes per single axle, with a maximum of 16 tonnes for a vehicle with two axles. With a three-axle vehicle the maximum permissible weight is 24 tonnes. These legal limits are almost certain to be reduced, and operators are reluctant to buy new vehicles until they know what the new regulations will be. Those who are buying new vehicles naturally look with favour upon lightweight ones.

The two indicators to the right of the instrument panel of the Pekol bus show which gear is in operation and which is preselected

Increased attention is being devoted to ventilation, heating, and even full air conditioning of buses and coaches. On several vehicles there are no opening windows and ventilation is effected either by controllable intakes and outlets in the roof and rear quarters, or by the more conventional arrangement of ducts on one or both sides of the floor. One vehicle that was exhibited at Frankfurt has a complete air conditioning installation with automatic temperature and humidity control. Careful control of ventilation is a most important feature for vehicles intended for operation under very cold winter conditions in northern territories. In these circumstances, windows cannot be opened, but good ventilation is essential for the maintenance of reasonable standards of comfort.

So far, underfloor engine types of layout have not been widely adopted in Germany, either for goods or passenger vehicles. One of the objections to the underfloor layout for goods-carrying vehicles has been that manufacturers have felt that the ground clearance obtainable would be inadequate. However, these fears would appear to be unjustified in view of the fact that Büssing have introduced an underfloor-engined cross-country vehicle with ample ground clearance. German manufacturers generally tend to favour the rear engine position as an alternative to the traditional layout with the engine at the front. Büssing for some years have been the outstanding exception, although more recently Henschel have offered a horizontal engine. It is, perhaps, indicative of a trend towards the underfloor engine arrangement that Henschel have now developed two new designs of horizontal engine. The V-form of unit is also increasing in popularity. Kämper Motoren are now offering an eight-cylinder, V-type, four-stroke diesel unit and, of course, M.A.N. and Klockner-Humbolt-Deutz have been producing eight-cylinder four-stroke designs of this class for a number of years. Undoubtedly, the compactness of this layout is its main attraction.

There seemed to be but little to learn at Frankfurt so far as transmission systems are concerned. German manufacturers are not so far advanced in the field of two-pedal control as are their British competitors. Most of the new developments are concerned with improved electro-pneumatic and other systems for preselection, but with final selection by means of a pedal. The various forms of ZF gearbox are most popular and the Voith transmission, with a torque-converter and a two-speed epicyclic train is fitted in some buses for service in congested traffic.



Accessibility for servicing is an outstanding feature of the Pekol bus

Kässbohrer Pekol

Among the many Setra buses and coaches exhibited on the Kässbohrer stand was a vehicle called the Pekol

Clearance for the springs of the Pekol independent suspension units is provided by semi-cylindrical inserts in the vertical panels of the wheelboxes

bus, which embodies a number of patents of Mr. Pekol, an operator from Oldenburg. This vehicle weighs 5,100 kg empty and 12,000 kg laden. It is designed to carry 90 to 110 passengers. Later models will be powered by the 125 b.h.p. six-cylinder horizontal engine, of Henschel manufacture, installed at the rear. In the model exhibited, the 100 b.h.p. vertical engine manufactured by Henschel had been installed in the horizontal position by Mr. Pekol.

An interesting feature of the arrangement is that the engine is mounted on a sub-frame, the longitudinal members of which are of channel section with their flanges outwards to contain the side members of the rear extension of the vehicle frame. Small wheels are mounted on brackets on the sub-frame and bear on the side members of the main frame in such a way that when the appropriate connections and controls have been disconnected and the rear cross member has been removed, the whole power unit assembly can be withdrawn to the rear. It is stated that an engine can be changed in two hours.

Access for servicing the injection pump and compressor, and for filling with oil, is gained by opening double, hinged doors at the rear. There are two removable panels, one on each side at the rear, through which access can be gained to the injectors on the right-hand side and the radiator on the left. Inside the vehicle, there are two hatches in the floor, one above the engine and the other above the gearbox to give access to the electro-pneumatic controls, which are of Westinghouse design. The preselection control for this gearbox is a small lever on the steering column, and final selection is made by a pedal. An unusual feature is an indicator on the dash in which numbers are illuminated to show what gear is in operation and which one is preselected.

The vehicle is of the forward-control type and has a curved screen with a vertical pillar at the centre. This arrangement gives the driver a good field of vision. The side lights do not open, but there is a sliding panel beside the driver, which he can open for signalling, and, for air extraction, there is a hinged glass ventilating panel on each side at the rear. Thirteen separate ventilating units are fitted in the roof. In the interests of weight reduction, Multoprene foamed plastics is used in the seat cushions and squabs. Interior lighting is effected by U-shaped fluorescent tubes fitted in the roof.

All riveted, light alloy construction is employed throughout, and the structural design, in general, is based on aircraft principles. Independent suspension units are fitted both at the front and at the rear. Each unit comprises a pair of unequal length wishbones, two co-axial coil springs, together with a hollow rubber spring, which acts as a bump stop, and telescopic, hydraulic dampers. The spring assembly is interposed between a platform on top of the swivel pin knuckle and a bracket under a box section, arched member in the wheelarch. As can be seen from the accompanying illustration of the interior of the bus, the inner vertical face of the wheelarch has a semi-cylindrical bay formed in it to provide clearance for the spring. Not only does this co-axial spring arrangement economise in space, but it is also a safety factor, since the vehicle will ride satisfactorily even with one spring broken. It is stated that a spring change can be effected by one man in 15 minutes.

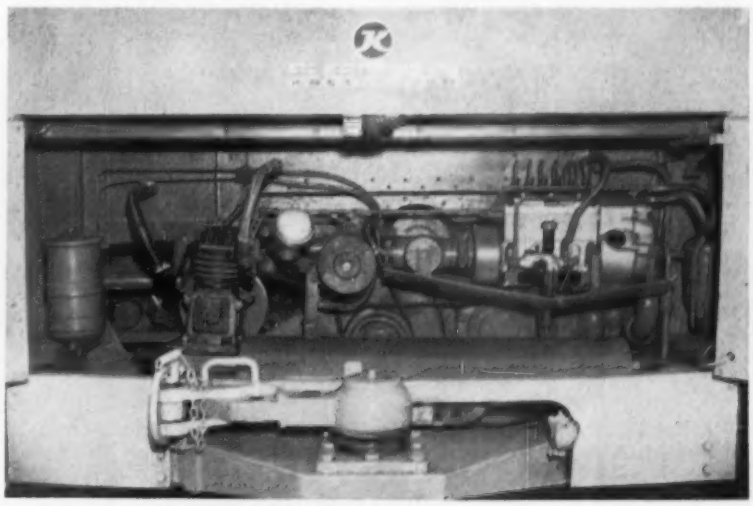
Accessibility and ease of repair are noteworthy features of this vehicle. The small exterior mudguards are of rubber, and the body panelling is divided into sections that are easy to replace in the event of damage. A panel forming the front grille can be removed to disclose the heater and electrical units, as well as the steering and brake controls. The steering box is mounted between the front wheels and a train of universal joints transmits the drive from the lower end of the steering column to the control shaft of the box.

A short road test, with only eight people on board, showed that the ride obtained by passengers seated between the front and rear axles is better than that experienced in modern private cars. Because of the pitching motion of the vehicle, the ride at the front and rear ends was not quite so good, but this might be improved when the vehicle is fully laden. In any case, the pitching was scarcely noticeable except when the motion of the bus in relation to near-by objects could be observed. Even when the vehicle was driven at a speed of about 50 k.p.h. over a field, no discomfort was felt. The roll stiffness is exceptionally good.

Henschel

A new development by Henschel and Sohn, G.m.b.H., of Kassel, is their HS 160 USL omnibus. It is powered by the Henschel six-cylinder underfloor engine, type 514 DCV, which develops 163 b.h.p. at 2,200 r.p.m. The engine capacity is 9·35 litres and it has a 115 mm bore by 150 mm stroke. An electrically operated ZF Hydromedia gearbox is installed in the town bus, and in the long-distance coach the ZF 6M-50, six-speed gearbox is employed. The ZF Gemmer, power-assisted steering arrangement has been adopted.

As a town bus, the vehicle weighs 7,000 kg empty, its normal laden weight is 12,900 kg, and under peak traffic conditions it weighs 14,850 kg. It has a normal capacity for 29 seated passengers and 60 standing, but in the peak hours it can carry 89 standing—these figures do not include the crew



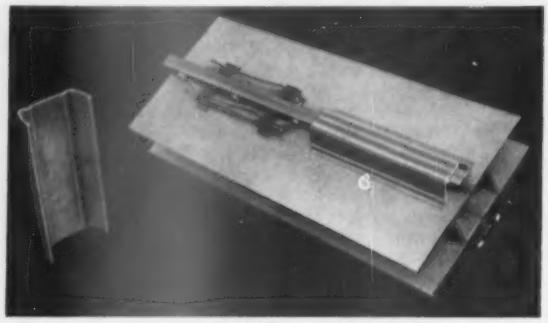
In the Pekol bus, the engine is mounted on runners and can be slid out after the rear cross member has been removed

of two. In the long-distance coach form, it carries, in addition to the driver, 56 seated passengers and their luggage; this is with nine seats in the central gangway.

Probably the most interesting feature of this vehicle, from the design point of view, is that the body comprises six self-contained units, so that it can be exported in the CKD condition. Each of these units is a complete assembly, so, after they leave the factory, there is no work entailed other than fitting them together at their destination. This means that assembly can be effected by unskilled labour. The six components are: the basic underframe structure below a level half-way up the waist panel, the canopy and screen at the front, the centre component of the roof panel, the two side panels, including the waist and cant rails, windows and outer portions of the roof panel, and the sixth component is the rear end of the body.

The Henschel HS 160 USL vehicle has coil springs and a beam axle at the front, and conventional semi-elliptic springs at the rear

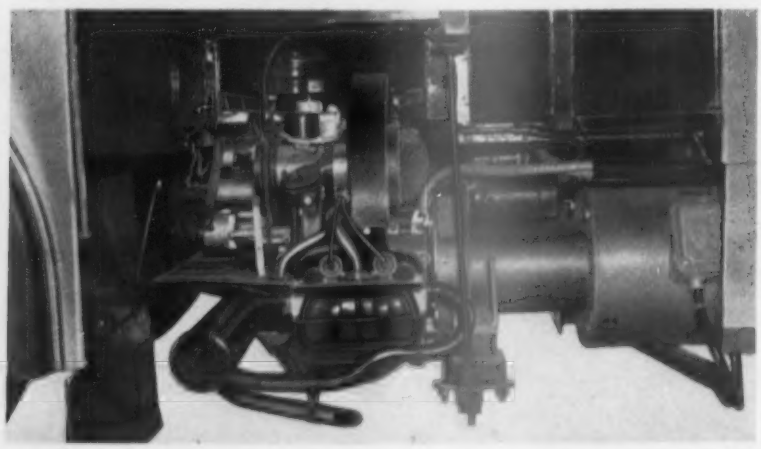
A patented arrangement is used for the horizontal joints between these components. It comprises two top hat sections, the flanges of which are lipped. These sections are spot welded between the inner and outer panels at the horizontal joints where the components abut. The flanges of the top hat sections are bolted together to assemble the components of the vehicle; the bolts are concealed on the outside by a rubber moulded section and on the inside by an aluminium alloy extruded section. Both the rubber and the aluminium mouldings are lipped internally so that they can be sprung over the lipped edges of the flanges of the top hat sections.



Some specimens of the sections employed at the horizontal joints between the main assemblies of the Henschel coach

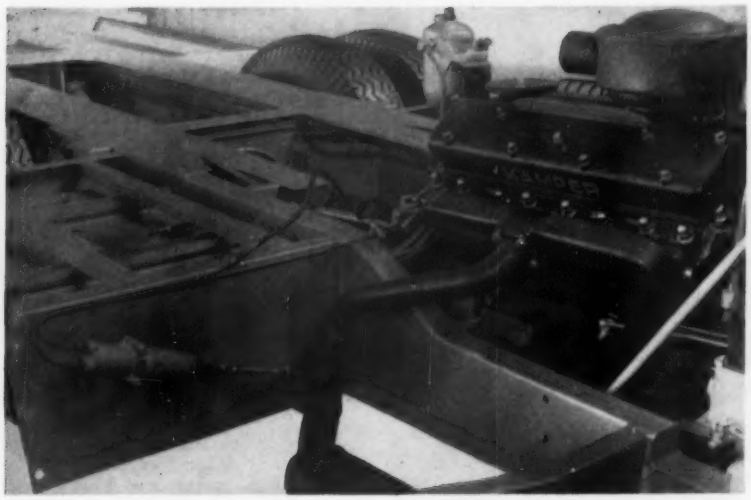
As can be seen from the accompanying illustration of the bus, the rubber section forms a rubbing strip on the exterior panelling, below the waist rail. It has a cream plastics strip insert on each side of its crown, to stiffen it so that it will not fall off after assembly. The aluminium alloy extruded sections are employed in the interior. A larger section conceals the interior joint on each side of the central roof panel, and carries the roof lamps. This section is lipped at its edges and is held by spring clips, which also carry the electrical wiring conduits. The conduits are of U-shape and are sprung, so that the cables are simply pressed into them by hand. All these details can be seen in the illustration of a specimen section. The interior panel of the centre component of the roof is of plastics material, so it is Chobert riveted instead of spot welded to the lipped top hat section edge-pieces. In case of damage, the exterior skirt panels are detachable, and those parts of the mudguards which are below the level of the top of the skirt panel are of rubber.

The windows are fitted with frameless hinged ventilating strips of Sekurit glass extending along their upper edges. These strips are hinged at their lower edges, to which are fitted glazing rails. A toggle action lock is mounted in the centre of each, and both the upper link of the toggle and the glazing rails are secured by bolts passed through holes in the glass so that there is no danger of their coming off, as there might be if they were attached in any other way. Four ventilators are fitted in the roof panel, each with a three-position control. The positions are for: extraction, intake, and closed. Another interesting feature of the bus is that all the vertical stanchions or handrails, are mounted with their ends in rubber rings secured with a ring nut. This avoids the need for specifying close tolerances for the assembly of these components, and it also prevents their rattling during service.



In the Henschel trolleybus, a Volkswagen engine drives a generator to provide power to move the vehicle over short distances where overhead lines are not available

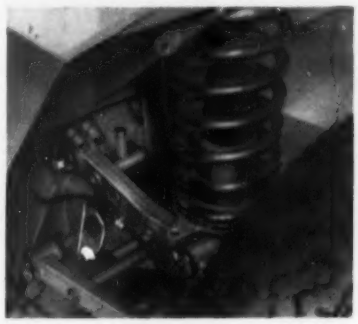
Conventional semi-elliptic springs are employed at the rear, but at the front, coil springs are used in conjunction with a beam axle. A Panhard rod, together with a trailing A-link, fabricated from channel sections, locates the axle. Coil springs can be spaced more widely apart than semi-elliptic springs at the front, since they facilitate the provision of clearance for the wheels on lock. Nevertheless,



A hydraulic control unit is fitted on each side of the Orion chassis to actuate the exhaust brake

the spring base is not so wide as that obtained with independent suspension of the transverse wishbone link type. The reason for fitting coil springs despite the fact that the layout is more expensive than the conventional semi-elliptic spring arrangement, is that in this way the transmission of shocks to the body as a result of interleaf friction is obviated. Although the unsprung mass is higher than that which would be obtained with independent suspension, the ratio of sprung to unsprung mass is probably not unfavourable.

An interesting feature of the trolley-bus exhibited by Henschel is the Volkswagen engine installation to drive a generator, which supplies current for moving the vehicle in and out of the garage, or in circumstances where the overhead power supply has temporarily failed. The fully laden vehicle can be moved at a speed of 20 k.p.h. by means of this motor-generator set. The Porsche engine, which rotates at a higher maximum speed, can be employed to give a generator output of 400 volts, instead of the 220 volts obtainable with the Volkswagen installation. With the Porsche engine installation, the maximum vehicle speed obtainable, of course is higher.



Hollow rubber assister springs are mounted inside the main coil springs of the front suspension of the Orion coach

Orion

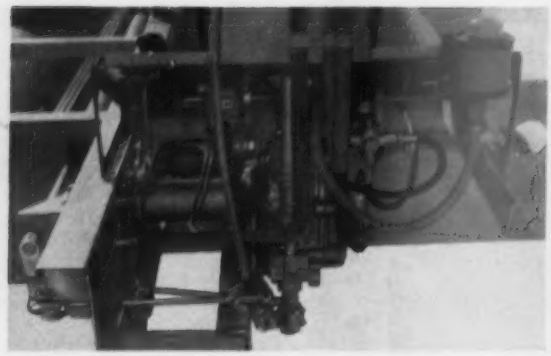
The Orion rear-engine coach, type WH 160, is another vehicle of semi-chassisless form and with an unusual suspension arrangement. In designing this vehicle, the manufacturers set out to obtain a low centre of gravity, a ride comparable with that obtained in private cars, adequate ventilation to add further to the comfort of the passengers, and good visibility all round. The improved ride has been obtained by the employment of independent suspension at the front and a coil spring and conventional axle arrangement at the rear. The ventilation system has been so arranged as to completely change the air in the coach from 30 to 60 times per hour. Excellent visibility has been obtained by making the side windows between 42 and 51 in wide.

Since thermos-trucks and pantechnicons have much in common with buses and coaches, so far as dimensions and load are concerned, the semi-chassisless type of construction has been adopted. This has enabled the basic frame to be used for a number of different types of vehicle, and the chassis is self-contained so that it can be driven to different coachbuilders if necessary. In addition, many of the structural components of the passenger vehicle body can also be used in the other vehicles.

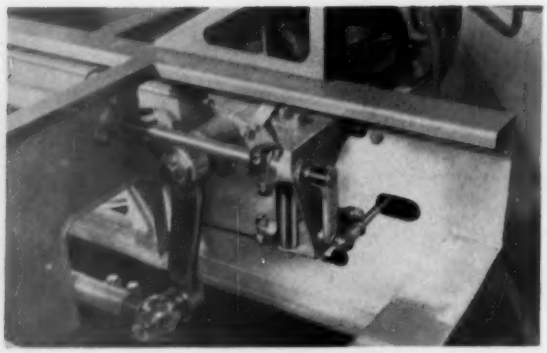
The side members of the frame are light channel sections, about 14 in deep. The flanges of the channel sections are lipped inwards to make them more stable under compression loads. These side members are 20½ in apart at the front. They are parallel from the front to a point just forward of the rear wheels, where the channel section is closed by welding another channel section to it. These two sections are welded edge-to-edge. Behind the rear wheels, the frame is cranked outwards to clear the engine installation. Gusset plates are attached to the top and bottom edges of the side members and they extend from a point well forward of the suspension to about halfway between the rear of the suspension and the engine. These gusset plates are secured by tack and plug welding.

Four rubber mountings carry the engine. They are bolted to the inner faces of the side members. The two at the front are of rectangular form and are so shaped as to provide fore and aft location. Each comprises a cradle bolted to the bracket on the side member and a V-shaped metal component secured to the engine, and rubber is bonded between the two. Vertical loads are taken partly in shear and partly in compression, while fore and aft movement is restricted by the rubber acting in compression between

A ball-jointed V-link helps to locate the rear axle of the Orion coach



The forward control assembly on the Orion coach chassis



Details of the gear shift control linkage on the Orion vehicle

the flanks of the V and the cradle. The rubber below the V is slotted to reduce the vertical rate. Two circular sandwich type units support the rear end of the engine.

The rear cross member of the frame is bolted on, to facilitate engine withdrawal. It is of heavy channel section and is equipped to take a trailer drawbar. There is a second cross member immediately behind the rear wheels. It is of box section and has a large hole through it to clear the short propeller shaft between the gearbox and rear axle. Each end of the axle passes through an arch-shaped cut-out in the lower edge of the side member. The cut-out is closed at its base by a bolted-on inverted bridge piece. A rubber rebound stop is cradled in the bridge piece.

Another box section cross member is fitted between the side members in front of the axle. This member carries the ball-jointed ends of the V-link that helps to locate the axle. The gusset plates above and below the side members extend across the chassis at this point and are welded to the upper and lower edges of the cross member.

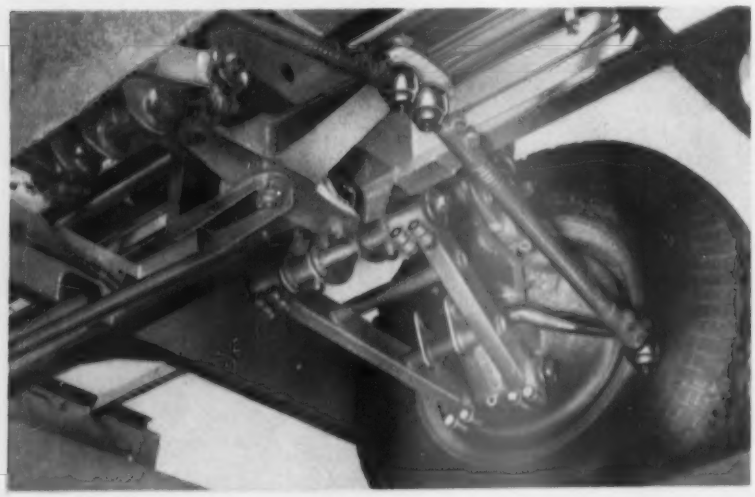
Forward of this cross member there are two light-section cross members of little more than half the depth of the others. They are incorporated simply to support the pipes of the pneumatic system. A heavy box section cross member is welded between the side members near the front to carry the independent suspension units. Forward of this member there are three more relatively light cross members. One carries the pneumatic pipes, the second is a floor cross bearer to stiffen the area adjacent to the front entrance, and the third is a towing pick-up. Outboard of the side members, and in line with each cross member, channel section outriggers of the same depth as the side members are welded on to carry the bolted-on body sides and to form cross bearers for the floor.

Shock absorber arrangement on the rear suspension of the Orion coach

Double transverse wishbone link type front suspension is employed. The two swivel pin bearings are carried in a knuckle on top of which is a platform for the coil spring. A short tubular extension on the centre of this platform carries a rubber auxiliary spring similar to the Aeon unit, described in the October 1954 issue of *Automobile Engineer*. As the suspension rises to the full bump position, this rubber spring bears against the pan that seats the upper end of the coil spring. This pan is mounted in the wheelarch, which is suitably reinforced to take the loads imposed on it.

Each wishbone link comprises two box section arms formed by welding together two channel sections. The arms are connected by a pair of tubular ties. The telescopic shock absorber passes between the pair of tubes that connect the arms of the upper wishbone and is attached to the outer tube of the two that connect the arms of the lower wishbone. Rubber bushes with inner and outer metal sleeves are clamped in split bosses on each end of the arm. Thus, there is only one lubrication point, and this serves the swivel pin bearings.

At the rear, there are two coil springs at each end of the axle. These springs are carried on the ends of a yoke, clamped with its centre above the axle, and their upper ends seat in pans welded beneath the gusset plate on top of the frame side member. The telescopic shock absorber is mounted between the frame and the rear end of the yoke that carries the two springs. A hollow rubber assister spring is



A view of the underside of the front suspension of the Orion vehicle

In the Orion coach, two of the seats on the right-hand side at the rear tip forward to facilitate entry through the door, and the seats over the wheelboxes are higher than the others and have footstools in front of them. In the illustration on the right, the rearmost seat is moved towards the centre of the gangway and the other seats are shown with their adjustable squabs in different positions

mounted under the gusset plate above the axle. Lateral location of the axle is effected by a V-shaped link, which has the ends of its arms secured to a frame cross member forward of the rear wheels, and its apex attached to the top of the axle casing. Additional location is afforded by two trailing links, one at each end of the axle, secured to a lug under each side member of the frame and to a second lug under the axle. All these links are adjustable, and ball joints are fitted at their ends. The ball joints are lined with Fulkanol plastics material so that they require no lubrication.

The power unit is the Kämper V-eight, water-cooled diesel engine. Its output is approximately 175 b.h.p. at 2,250 r.p.m. A ZF AK5-33S gearbox is employed. The gear shift control is a relatively large diameter tube divided into four sections connected by short lengths of rod, which are inserted in the ends of the tubes and carried in bearing sleeves housed in the frame cross members. Rubber rings seal the ends of these bearings so that they do not require lubrication during service. The employment of rods to act as bearings and to join the sections of the tube, avoids the use of excessively large bushes and also helps to reduce the friction in the system. A tube type of control is used, of course, to give adequate stiffness over the relatively long length from front to rear of the vehicle. The connections between the steering column gear shift lever and this control rod are shown in the accompanying illustration of the front end of the chassis.

Inside the coach, the general arrangement, trim and finish are excellent. A floor covering, with a texture like rubber but with a high gloss finish, is employed. The wheelarches are rubber-covered. The seats are so arranged that no space is wasted adjacent to the wheelarches. At the rear, the pair of seats over the wheelarch on each side is higher than the remainder, and a footstool is mounted on the floor to compensate for this increase in height.

The angle of the squabs can be adjusted by pressing a knob control under the armrests and pushing backwards. If the pressure against the back of the seat is slackened, the squab returns to a more vertical position under the influence of a tension spring. The pawl and ratchet mechanism and the spring are housed in the armrest. Pull straps, pockets and ash trays are fitted in the back of each squab. The distance between the back of each squab and the front of the cushion behind it is 19 in.

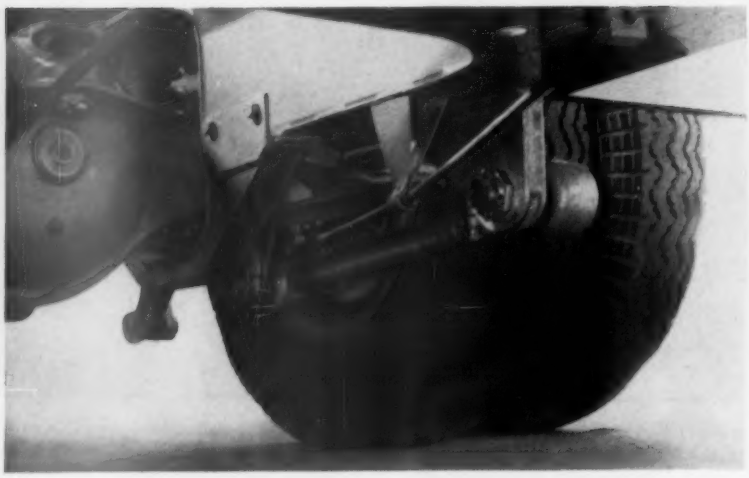
Hide trim is employed and the seats are yellow and are finished with pale blue piping. The roof trim is a cream-finished board. All the metal components, such as the luggage rack and lamp bezels, are of anodized aluminium with a gold finish. A noteworthy feature is the use of gold-finished anodized aluminium wire for decorative purposes. This is shown in the illustration of the interior at the rear of the coach. Plastics impregnated, figured timber panels are employed below the waist on each side, and also for the dash facia.

Ventilation is afforded by horizontally sliding strips of glass at the top of each

This Orion coach has independent suspension at the rear as well as at the front

side light. In addition, under the screen head rail there are air intakes serving ducts on each side of the roof. The air is discharged from these ducts through a slot extending almost the full length of the vehicle on each side of the centre panel of the roof. One heater is fitted in front of the rear wheelarch on the left-hand side and there is another at the front under the dash. For summer conditions or for operation in hot climates, additional ventilation can be obtained by opening two roof lights, one at the front and the other at the rear. These lights are lifted on parallel links by two electric motors, one for each, and the control is on the dash. Each is about 2 ft 6 in square.

A short road test of this vehicle showed that the suspension was firmer than that of the Pekol bus, already described. This is because the Orion coach is not equipped with independent suspension at the rear. However, only four passengers were carried and by normal standards the ride was good, even at about 50 k.p.h. over a field. When the vehicle was driven round a fairly sharp corner at 35 k.p.h., it displayed good roll resistance. At one point on the test route the vehicle was driven round a round-about so fast that the tyres were squealing and both the handling of the vehicle and its roll resistance appeared to be good. It is stated by the manufacturers that after the prototype had done 120,000 km, the tyres were examined and had worn only 60 per cent. The rear engine was quiet even to passengers in the rear seats. When the hinged glass ventilating panels on the rear quarters were open, some noise could be heard through them. Although a model with independent suspension at both the front and the rear was exhibited in the Show, a second vehicle was not available for road testing. The suspension units for this vehicle are practically identical with those employed at the front of the coach already described.



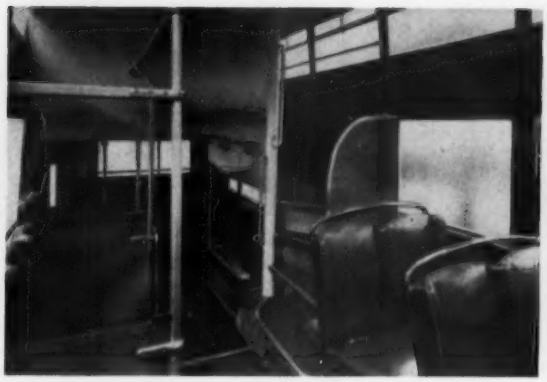
A view, from below, of the rear suspension of the Orion coach chassis

Aero 1½-deck bus

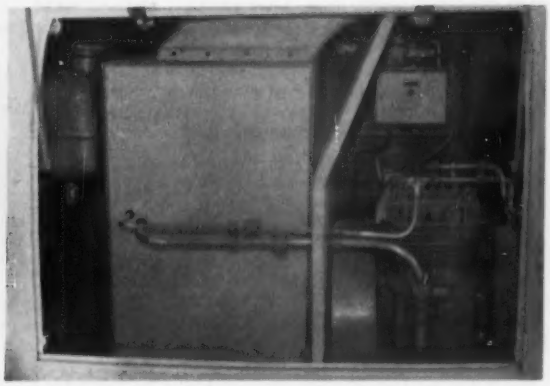
Double-deck buses are not widely favoured in Germany largely because many bridges in that country are not high enough to clear them. However, for the method of operation generally adopted, that is with the conductor seated adjacent to the loading platform, the 1½-deck arrangement has some advantages. In the Aero bus, the loading platform is the lower deck at the rear and the conductor's desk is approximately over the rear wheels, with the stairs to the upper deck almost directly in front of him. This type of vehicle is also suitable in some respects for luxury coach operation, since the lower deck can be used for the stowage of luggage or as a bar or galley for the preparation of meals. In fact luxury coach bodies designed on these lines are available on this chassis. The bus has accommodation for 50 seated passengers and 100 standing during peak traffic periods; normally there is space for 70 standing passengers. Seventeen of the seats are in the upper deck. The coach version is equipped with 60 seats.

A Büssing underfloor engine chassis, type 6500T, with a 5¼ m wheelbase, is employed. The coachbuilders have lengthened the chassis to carry the loading platform at the rear and have added two independently sprung wheels to take the extra weight. These wheels are immediately behind the rear axle of the original chassis. They are suspended on a transverse leaf spring which forms the lower arms of the double transverse link system. An

When the Aero 1½-deck bus is converted for luxury coach operation, the rear part of the lower deck can be used as a bar or galley



There are only four steps to the upper saloon of the Aero 1½-deck vehicle



A 7·5 b.h.p. petrol-engine driven compressor is employed in the refrigeration plant in the Trutz coach

upper arm is fitted on each side together with a telescopic shock absorber. The overall length of the vehicle is 11·7 m, and its height in the unladen condition is 3 m 65 cm. In the unladen condition, the vehicle weighs 10½ tonnes and the all-up vehicle weight is 21 tonnes.

There is a bench type seat for three people along the side opposite the entrance on the lower deck at the rear. This seat is for invalids and elderly people who cannot easily move further into the bus. Above it, in the between-decks floor, is the well that forms the gangway in the upper deck. The manufacturers state that the distances between the roof and seat cushions and between the roof and the floor in the upper deck are the same as in the Berlin double-deck buses. However, the clearance is appreciably less than that which is the general practice in Britain.

Ventilation in the upper deck is effected by opening horizontally-sliding transparent glass ventilating panels at the top of the side windows. There are only four steps down to the lower deck, where the side windows are hinged at their bottom edges and have a toggle link latch at their upper edges. To prevent draughts, leathercloth gussets are fitted between the vertical edges of each window and the frame pillars. Passengers enter through the rear doors and leave through a double door at the centre and a single one opposite the driver.

Trutz

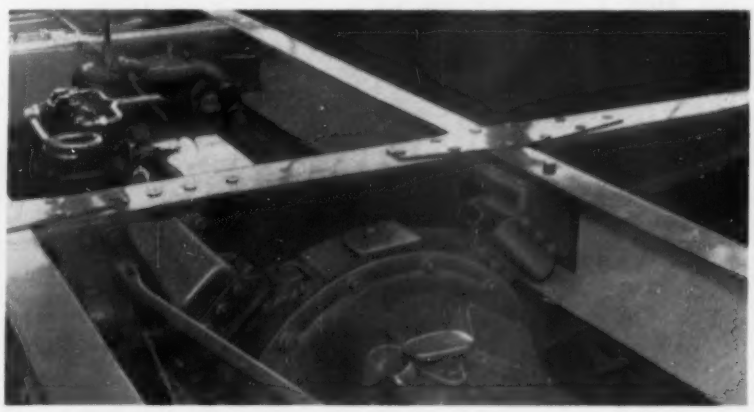
The coachbuilders Karosseriefabrik N. Trutz-Coburg showed a vehicle on a Henschel chassis. An interesting feature of this coach is that none of its windows open and it is equipped with an air conditioning plant made by Escher-Wyss of Lindau-Bodensee. This plant is installed in the back of the vehicle, and access to it is gained through a door in the rear panel. A heater is fitted behind the grille at the front of the vehicle where the air intake is. This heater is operated by engine coolant and, of course, can be switched off if the ambient temperature is high. The air, heated or otherwise, passes through a duct under the floor of the vehicle to the rear and thence through a refrigeration plant. If the heater is in use, the refrigerator, of course, is switched off,

On the Büssing underfloor engine chassis, fore and aft location of the power unit is effected by the front mounting

and *vice versa*. From the refrigeration plant, the conditioned air is directed into a duct along the crown of the roof and is discharged into the vehicle through four apertures. A rectangular plate is fitted below each aperture to direct the air flow more or less horizontally under the roof and thus to shield the passengers from draughts. The outlet for stale air is on the heelboard below the rear seats.

About 1,200 m³ of fresh air are taken in per hour and from 400-600 m³ per hour are bled off from the outlet, mixed with the fresh air and recirculated. Humidity control is effected by undercooling the air and draining away the condensation. A thermostat for automatic temperature control is mounted on the interior luggage rack. The manufacturers consider that under even the hottest ambient conditions, it is only necessary to reduce the interior temperature to a level about 6-8 deg C below the exterior temperature to make the vehicle comfortable. If the temperature is reduced below this level, the occupants feel too cool. To reduce the load on the heating or refrigerating plant, honeycomb paper type insulation is fitted between the inner and the outer panels of the sides and roof. There is no insulation under the floor.

A 7·5 b.h.p. petrol-engine driven compressor is installed in the refrigeration plant in the vehicle exhibited. The compartment in which it is housed is



A view of the Büssing chassis, showing the engine mountings and butt-strap arrangement employed to join the frame cross members and their outrigger extensions

well insulated so the noise level in the coach is surprisingly low even when the main diesel engine is not running. Nevertheless, later models will be equipped with an electric motor. The fan for circulating the air is in the housing that contains the refrigerator.

Büssing

Büssing claim that their type TU11 Trambus is the first vehicle in Germany to have three double doors. Each of the three is about 52 in wide between the pillars; the effective width between the doors, when they are open, is 46 in. There are only two steps up to the rear entrance but the other doors, which are exits, have three steps. The weight of the chassis is 5,700 kg and under normal traffic conditions the laden weight of the vehicle is 14,100 kg. Under peak traffic conditions the maximum load is 16,000 kg. The wheelbase is 5·55 m, the front track 2·003 m

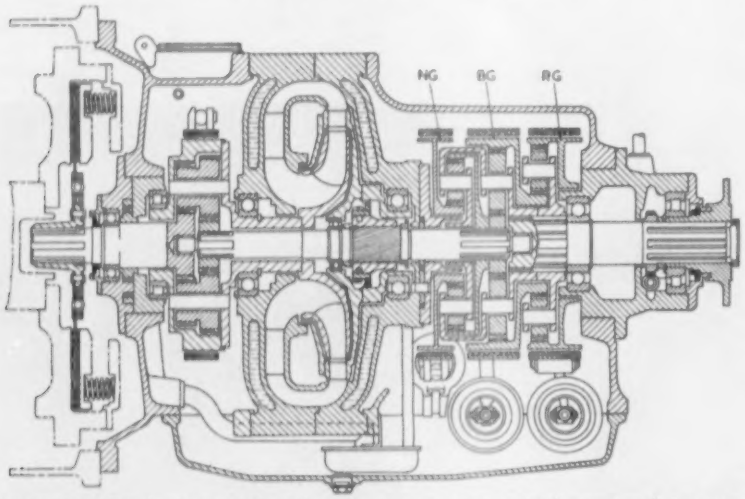
Krupp employ ball-jointed drop links to connect the anti-roll bar to the axle

and the rear track 1·725 m. So far as overall dimensions are concerned the length of the chassis is about 11·505 m and its width 2·394 m. In the laden condition, the frame is 90 cm above the ground.

The vehicle is powered by the Büssing U11, 170 b.h.p. underfloor diesel engine. This unit develops its maximum b.h.p. at 2,200 r.p.m. and its maximum torque of 499 lb-ft is developed at 1,300 r.p.m. The bore and stroke are 122mm and 155mm respectively and the piston displacement is 10·78 litres. A fuel consumption of 14 m.p.g. is claimed for this vehicle

The Büssing six-speed constant mesh gearbox is fitted as standard equipment. However, as an alternative, a four-speed constant mesh box can be supplied. For urban and short-haul operation the Voith Diwabus transmission can be installed. Details of this transmission unit are shown in the general arrangement below.

With the Voith transmission, the drive is transmitted to a primary shaft through a single dry-plate clutch. On the rear end of the primary shaft is a sun gear. This sun gear meshes with a a set of double planet gears which in turn mesh with another sun gear splined on to a shaft that passes through a torque converter and transmits the drive to an epicyclic gearbox at the back of the unit. The carrier for the double planet gears is fixed to the pump element of the torque converter whilst the turbine element is connected to the shaft that transmits the drive to the epicyclic gearbox. Thus, the sun and planet arrangement between the clutch and the torque converter acts as a torque divisor. When the reaction back from the gearbox increases, the share of the load taken by the torque converter also increases. A brake band can be applied to the planet carrier to lock the torque converter so that the drive is entirely mechanical. In the epicyclic gearbox there are only three speeds. They are: normal gear, mountain gear and reverse gear.



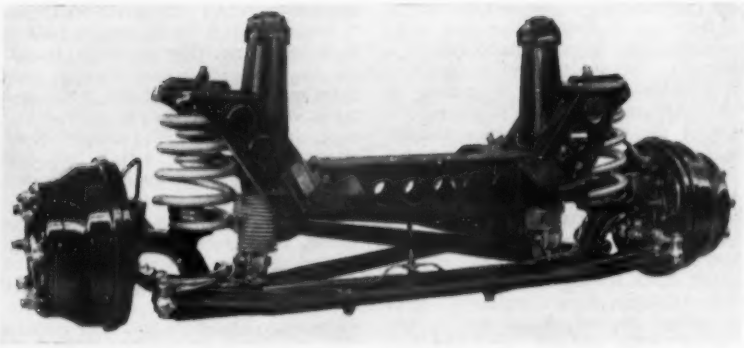
In the Voith Diwabus transmission, there is a torque converter with a torque divisor gear in front and three epicyclic gears behind it. The three epicyclic trains are: normal gear NG, mountain gear BG, and reverse gear RG

On the Büssing chassis, the anti-roll bar assembly is mounted between the semi-elliptic springs and the frame

A fairly conventional frame is employed for this semi-chassisless vehicle. It comprises two channel section side members, which are straight from a point in front of the front wheels to behind the rear ones. The front and rear ends are cranked down to reduce the height of the loading and unloading platforms. Top hat section cross members are fitted, between the side members, in front of and behind each wheel. Another cross member is fitted at the centre of the chassis to carry the main mountings for the engine. The ends of these cross members are flanged and riveted to the side members, and butt straps are riveted above and below to connect them to the outriggers that carry the body. These outriggers are also of top hat section but they are reduced in depth towards their outer ends. A lighter channel section cross member carries the front engine mounting.

The engine mounting system is good. Axial location is effected at the front, where two sandwich type units are arranged V-fashion. These two units seat on a single V-section bracket bolted to the frame cross member. The upper plates that rest on the rubbers are bolted to the engine. The forward end of each plate is turned down into a channel in its rubber, so that axial loads are reacted by the rubber in compression. The unit is fairly free to oscillate torsionally since this motion places the rubber in shear.

Two sandwich type rubber mountings of an unconventional design are employed at the rear. They are fitted one each side of the flywheel housing. In each there are two angle section plates, placed back-to-back to form a T-section. The foot of the T is bolted to the flywheel housing, and the arms seat on the rubbers, which are supported by angle section plates bolted to the frame. As can be seen from the accompanying illustration, the units are arranged so that torsional oscillations are taken by shear in the rubber, while the



A coil spring and beam axle arrangement is employed for the front suspension of the latest Mercedes-Benz coach, and the whole assembly is carried on a cross member which is rubber-mounted under the vehicle structure

weight of the engine is taken in compression. The rubber is slotted adjacent to the ends of the arms of the T-section and also along the lower edges of the angle plates, so that the unit takes no part in locating the engine axially and does not have to be accurately positioned relative to the front mounting.

The conventional semi-elliptic spring type of suspension has been adopted, both at the front and at the rear. Hollow rubber assister springs are fitted between the axles and the frame. At the rear, the semi-elliptic spring is underslung below the axle and an anti-roll bar is carried in rubber bushes in brackets under the side frames. The lever arm at each end of the bar is connected by a short, rubber bushed shackle to the axle. It is of interest to compare this arrangement with that of the Krupp chassis, on which the anti-roll bar is carried in rubber bushed brackets above the frame side members, and therefore has to be connected to the axle by a drop link fitted with a ball joint at its ends and supplied with oil from the central lubrication system.

Mercedes-Benz

Mercedes-Benz have recently introduced a new bus which is termed the O 321 H model. It succeeds the O 3500 vehicle; some of these have been running in normal operation for as much as 300,000-600,000 miles. The outstanding characteristics of the new model are its light weight and large load-carrying capacity by comparison with its predecessor. A semi-chassisless type of construction has been adopted. It is based on a large box section longitudinal member extending from immediately behind the front wheels to a point well to the rear of the back wheels. The vertical sides of this box extend to the extreme front and rear ends of the vehicle. Adjacent to the front wheels, each side member is duplicated by another, the ends of which are attached to its outer face. These secondary longitudinal members are spaced a few inches outboard of the main ones. Square section tubes are welded to the upper and lower edges of the vertical side members of the box section which of course, extend to the extreme front and rear ends of the vehicle. The floor cross bearers are similar in construction to the side components of the central box member and are the same depth. The spaces between the central cross bearer and the two adjacent to it, one behind the front wheels and the other in front of the rear wheels, can be used for luggage lockers.

The rear engine layout has been adopted because it has been found to be quiet and there is less possibility of fumes entering the coach. Moreover, the space above the frame can be better utilized with this layout than when a vertical engine is employed at the front. The manufacturers state that with the rear engine layout it is also possible to obtain even weight distribution over the two axles.

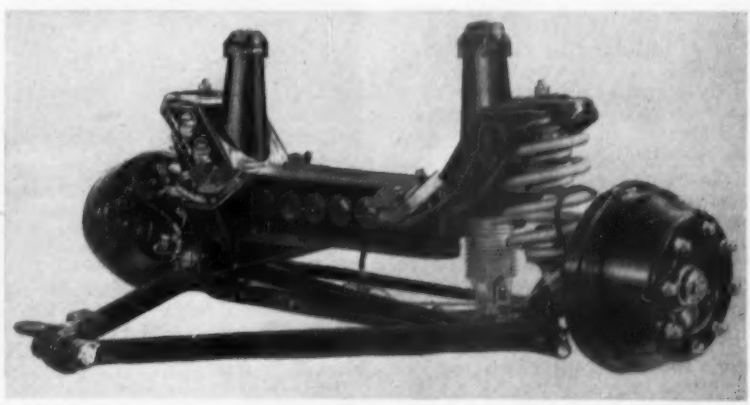
A water-cooled, six-cylinder, in-line diesel engine is employed. It is arranged vertically with its axis in line with the longitudinal axis of the vehicle. This layout, of course, is less complex and expensive than the transverse engine arrangement sometimes adopted. The bore and stroke of the unit are 95 mm and 120 mm respectively. Its swept volume is 5·1 litres and the compression ratio is 19·5 : 1. The power output is 120 b.h.p. at 3,000 r.p.m. The top speed of the vehicle is said to be 59 m.p.h.

A relatively low fuel consumption has been obtained by the employment of an eight-hole injector to give good distribution of fuel. This is also said to reduce the noise of the engine. To economize in space, the radiator is mounted to the left-hand side of the engine, and the thermostat that controls the temperature of the system is designed to operate independently of pressure. To reduce the noise and the power requirements of the cooling fan, a two-speed drive has been developed. One speed is for summer conditions and the other is for use in the winter; the change is effected by shifting the belt. A five-speed all-synchromesh gearbox is employed. It is bolted to the front end of the engine and the whole assembly is rubber mounted on a sub-frame to facilitate removal of the unit for servicing.

A beam axle and coil spring arrangement has been adopted for the front suspension. The axle is located by a Panhard rod together with an A-link, the apex of which is pivoted on the frame forward on the axle. The A-iink also reacts brake torque since it is rigidly secured to the axle by two bolts on each side. A top hat section cross member carries the whole assembly, including the telescopic shock absorbers, which are finned at their lower ends. This cross member is rubber mounted on the frame. Four mountings are employed, two on each side.

The coil springs are not of plain cylindrical form but are reduced in diameter at their ends where they are secured to their seats by a single bolt and large diameter washer. A second coil spring is mounted inside each main one and is secured together with a rubber stop at the upper end of the assembly. It acts as an assister spring, since it is only about half the length of the main spring, and therefore does not come into action until the axle has lifted approximately half way towards the full bump position.

A Daimler-Benz recirculating ball



A V-link, together with a Panhard rod, locate the beam axle of the Mercedes-Benz suspension unit

type steering gear is employed. The box, of course, is in the forward position at the base of the steering column, and the drop arm is connected by means of an adjustable rod to one end of a centrally pivoted idler lever mounted on the vehicle structure between the steering box and the axle. A long rod connects the other end of the idler lever to the steering arm on the wheel assembly. The centre of the ball joint that connects this long rod to the idler lever is adjacent to the pivot of the A-link that helps to locate the axle and takes brake torque. Thus, the rise and fall of the suspension should not interfere with the steering. An unusually large angle of wheel lock has been obtained by the employment of the coil springs. This angle is 52 deg, and the turning circle swept by the body is 52·4 ft diameter. A steering damper is incorporated to make driving over long distances less tiring.

The rear suspension is of conventional design with semi-elliptic springs. An anti-roll bar is incorporated. The actuating arms on each end of the bar are H-section forgings. They are connected to the axle by means of drop links with rubber end fittings. There are two rubber bump stops at each side of the axle. An unusual feature is that threaded bushes are employed in the spring eyes and shackles. This arrangement has been adopted, of course, to increase the length of life of these components. The axle ratio is 5·72 : 1.

There are three separate brake systems. The first is a conventional vacuum-assisted hydraulic foot brake, another is the handbrake and the third is the exhaust brake. When the accelerator and clutch pedals are actuated, the exhaust brake is automatically disengaged. This prevents damage to the system if the driver forgets to release the exhaust brake before accelerating.

Six different versions of this vehicle are built. They are: an inter-city bus, an all-weather bus, two types of transit bus and two types of de luxe coach. The inter-city and all-weather buses are licensed to accommodate 37 seated passengers. In addition, 10 folding seats are provided so that the seating capacity can be increased to 47. If more than 42 passengers are carried, 8·25-20 reinforced tyres must be fitted in place of the normal 8·25-20 tyres. The transit bus accommodates 50-69 passengers but this number can be increased to 84 if the reinforced tyres are fitted.

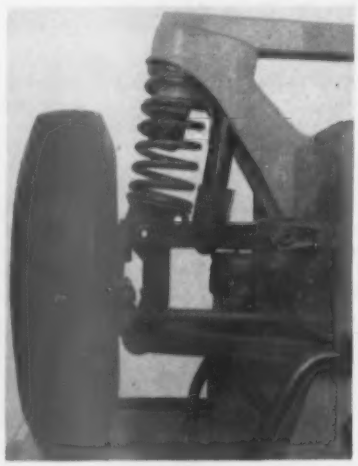
All the main members of the superstructure are of steel but the non-structural components are of light metal. A curved wind-screen, divided by a central vertical pillar, is employed. It is of laminated glass. There are four main windows on each side and each has a horizontally sliding ventilating panel at the top. At the rear, two deflector panels can be opened to serve as outlets for the stale air. Both versions of the transit type bus have compressed air operated, folding doors forward of the front axle, and another door is incorporated either in front of or behind the rear axle, according to the customer's requirements, so that the bus can be operated by a driver-conductor or by a crew of two. An unusual feature of the vehicle is that the bumpers are mounted on rubber-to-metal bonded components. This should increase their effectiveness.

Some of the trim details are of interest. The side panels below the waist rail are of fibre board with a figured timber veneer finish. The seats in the buses are trimmed with leathercloth but special seats are employed in the luxury coaches. These special seats are of foam rubber covered with leathercloth and Perlon-Mokett and have adjustable back rests. Those adjacent to the centre aisle can be moved sideways to increase elbow room. The driver's seat can be adjusted vertically and horizontally.

So far as overall dimensions are concerned, the vehicle, of course, conforms with German regulations. The overall length is 9·23 m its width is 2·5 m and the height is 2·9 m. A ground clearance of 0·24 m has been obtained, and the front and rear track are 1·935 m and 1·7 m respectively. The wheelbase is 4·18 m. The inter-city bus weighs 5·37 tonnes and the transit bus weighs 5·27 tonnes.

Krupp

A riveted frame is employed in the Krupp bus chassis. The side members are not parallel, but taper in plan and elevation. They are arched over the rear axle, and a downward cranked rear extension is fitted. Two-stage, underslung semi-elliptic springs are mounted on the rear axle. They each have an eye at the forward end and a slipper block at the rear.



A coil spring and hollow rubber assister spring are employed in the Krauss Maffei independent front suspension system

There seems to be some divergence of opinion among continental manufacturers as to whether slipper blocks should be lubricated. Some recommend lubrication, while others employ blocks of hardened steel for the spring ends to slide on and say that the blocks should not be lubricated, since abrasive particles tend to collect in the grease and cause unduly high rates of wear. The main advantages of the slipper block arrangement are, of course, low cost and, provided the rate of wear is not high, reduced maintenance.

An anti-roll bar is mounted above the frame. Its actuating arms are splined on and its spigot ends, which are carried in rubber bushed bearings, are retained by bolted-on caps on the frame side members. The drop links that connect the actuating arms to the axle are ball-jointed at each end and, like the spring eyes, are lubricated by the centrally controlled system.

Single-acting, semi-elliptic springs are employed at the front in conjunction with hollow rubber assister springs. Damping is effected by telescopic shock absorbers. Again, the semi-elliptic springs have eyes at their front ends and slipper blocks at the rear.

ZF Gemmer power-assisted steering is employed. The unit is mounted at the front of the vehicle and is connected by an adjustable rod to a slave lever suspended from a bracket on top of the frame side member, adjacent to the spring eye. From this lever a short rod is connected to the steering arm on the wheel. This arrangement places the joint at the front end of the connection to the steering rod, on the centre about which the axle moves as it rises and falls when the vehicle travels over rough ground. The steering arm is a triangulated link. Its apex is connected to the control rod and its base is forked with an eye in each arm of the fork. A pin is passed horizontally through the eyes and is carried in a boss on the upper swivel pin bearing housing. The eyes are split and clamped to the ends of the pin.

A Krupp 150 b.h.p., two-stroke engine is installed vertically at the front of the vehicle. The radiator is on the left-hand side of the engine. An unusual feature of this engine is the exhaust brake arrangement. The braking is effected in the engine cylinders instead of in the exhaust manifold. To obtain this effect, a control is fitted to alter the camshaft timing so that the exhaust valves remain closed as the pistons move up to top dead centre. The control is effected by a lever on the steering column. A worm and quadrant arrangement at the lower end of the rod on which this lever is pivoted rotates a cross shaft, on the end of which is a fork that slides a control sleeve axially in a rear extension of the half speed wheel. The extension of the half speed wheel has spiral splines machined in it to fit similar splines machined on the outer periphery of the sleeve. Normal parallel splines are machined on the inner periphery of the sleeve; they transmit the drive to the camshaft. Thus, axial motion of the sleeve along the spiral splines alters the angular

relationship between the half speed wheel and the camshaft.

An intermediate bearing supports the propeller shaft that transmits the drive from the power unit to the ZF 3-HM60 gearbox mounted on the frame behind the engine. This bearing is trunnion-mounted. Rubber bushes carry the trunnion pins with their axes horizontal in a transverse plane. A one-piece propeller shaft transmits the drive from the gearbox to the back axle.

Kraus Maffei

Another vehicle in which independent suspension is employed was shown on the Kraus Maffei stand. It is of conventional design, seating 43 with an additional 5 in the gangway for long distance operation, or alternatively, for shorter routes, 41 seated and 16 standing passengers. The double transverse wishbone link type front suspension is employed, with semi-elliptic springs at the rear.

The front suspension assembly was shown separately on the stand. It is a more or less conventional wishbone arrangement, but the coil spring is mounted above the swivel pin instead of between the wishbones in the manner usually adopted for smaller vehicles. The wishbone bearings are exceptionally widely spaced. Each comprises two box section arms formed by welding together two channel sections. The two arms of the upper wishbone are not joined together, except by their pivot pins, because they have to be spaced far enough apart to clear the finned, lower end of the shock absorber, which is attached to the swivel pin knuckle. A welded-in insert joins the two arms of the lower wishbone at a point just inboard of the outer pivot bearing. All the pivot pins are of tubular form and are carried in rubber bushes.

A hollow rubber assister spring is mounted on an inverted pedestal in the upper spring-pan. As the suspension rises to the full bump position, the assister spring bears on the platform, on the swivel pin knuckle, to which the lower spring-pan is bolted. The shock absorber is parallel to the spring and its upper end is secured to an inward extension of the upper spring-pan; there is not enough length for it between the spring-pans.

THE THERMOPHIL THERMOMETER

A Portable Electronic Instrument

THIS small portable instrument, designed for general industrial use, is claimed to be more sensitive than thermo-couples and to register the temperature of liquids or emulsions and the surface of solids with an accuracy of ±1 deg C. Its reaction to variation of temperature is virtually instantaneous and a reading can be taken in two or three seconds. Thus, in addition to its use at any stage of production, it is particularly valuable in research, development or testing programmes for the determination of comparative values in relatively rapid succession.

The model illustrated, the first of several instruments manufactured by Ultrakust Gerätebau, Ruhmannsfelden, North Bavaria, Germany, covers a range of temperatures from 0 deg C to 210 deg C. Others for temperature ranges specifically suitable for various industries are already in production and instruments for ranges extending to −50 deg C and to 500 deg C will be available shortly. All are handled in Britain by Headland Engineering Developments Ltd., 164-168 Westminster Bridge Road, London, S.E.1.

The instrument comprises an electric resistance thermometer and, coupled by a 4 ft flexible cable, a probe embodying a thermo-sensitive element of a germanium-based alloy semi-conductor. This feeler element is 0·25 mm diameter only and thus, whilst the amount of heat withdrawn from the object under examination is practically negligible, the heat exchange is effected with great rapidity. Variation of the temperature of the element causes a corresponding change in its resistance value. This change of resistance influences an electronic valve, the anode current of which is amplified ×50, fed to the measuring instrument and indicated on the dial. A rotating switch on the handle of the probe enables the appropriate scale of the three inscribed on the dial to be selected.

Extension cables of any length may be fitted for the remote use of the instrument. Since the resistance of the probe is approximately 500,000 ohm, the resistance of even a long extension has no practical influence on the temperature measurement. The electronic valve is claimed to have a working life of 3,000 hr, representing a possibility of nearly 1,500,000 measurements. For energizing the instrument four standard dry batteries of the 1·5V and 22·5V hearing-aid type are employed. The effective life of these batteries is dependent on the rate of usage but typical periods range from 6 to 12 months. Change of battery tension is corrected by the setting controls and the batteries are discarded only when operation of the control fails to produce visible correction on the dial.

Complete with probe and 4 ft cable, the instrument weighs less than 2¼ lb

To operate the instrument, the cable plug is inserted, the top left knob is turned to position "E" and the button immediately below is depressed to energize. The instrument is then set by adjusting the needle to the highest scale value by turning the knob on the right. Periodically, it is advisable also to zero the instrument in order to ensure accuracy. This is effected in similar manner by turning the top left knob to "A," depressing the button and adjusting by turning the central knob by means of a screwdriver or a coin. Repeat adjustments may be necessary to bring the needle into correct register at both ends of the scale. With the instrument set, the top left knob is turned to the "Measure" position, the cover removed from the probe, the switch ring on the probe set to the appropriate dial scale, and the tip of the probe lightly contacted on the object to be examined. On depression of the push-button the temperature is immediately indicated on the dial.

Complete with cable and probe, the instrument weighs slightly under 2¼ lb. It can be supplied in a plastics carrying case of the "ever-ready" type with shoulder strap.

SHOW REVIEW NUMBER

The extra issue of the "Automobile Engineer" will be published as usual in connection with the London Motor Exhibition. It will constitute a critical review of the more interesting exhibits, including coachwork, and will have numerous illustrations of special features and design characteristics.

The Show issue will be available on November 23rd, and can be obtained by order from newsagents throughout the United Kingdom, price 3s. 6d. net. Readers are reminded that it is still necessary to make arrangements with the newsagent to make certain that a copy is secured.

TESTING INTERNAL HARDNESS

Emco-Intest Instruments Adaptable to Bores of Differing Diameter and Length

IN addition to a wide variety of external hardness testers of portable, bench and machine-mounted types, the Austrian firm of Maier and Co., of Salzburg, also produces a range of instruments for measuring the hardness of internal surfaces. These are now available from Stanton Machine Tools Ltd., Molesey Road, West Molesey, Surrey; the sole representatives.

The instruments are remarkably versatile in their application. Two standard models are capable of operation in bores of from 1⅛ in to 6½ in diameter and from 2⅛ in to 8⅝ in diameter respectively. Each is available equipped with one of three standard probes, housing the test load transmission gear, the clamping device and the indentor head. With these, measurements can be taken at any point in the bore at depths of from 1 in to 4½ in, 16 in, or 36 in. Probes of greater length for operation at depths up to a maximum of 118 in are supplied to special order. For larger diameter bores and greater depths of operation instruments of a modified design are built to meet specific requirements. In one respect they are claimed to be unique. They can be used with complete facility and accuracy in blind bores.

All the instruments operate on the principle of the application of a preliminary load followed by a full test load and direct indication on Rockwell scales. Load spring units, of guaranteed accuracy, are housed in steel cylinders and sealed. A range of eight interchangeable units for loads of from 15 kg to 187·5 kg (33 lb to 414 lb) and interchangeable diamond cone, diamond pyramid, and steel ball indentor units are available. In combinations of load and indentor, selected according to the recommendations of a synoptic table, it is possible to obtain readings on Rockwell B, C, or Superficial scales of the hardness of all ferrous and non-ferrous metals.

The Emco-Intest instrument entered into the smallest possible bore

Accuracy is within ±1 Rockwell and the surface of the work is not damaged by the test. The instruments are of robust construction, being designed specifically for use in the workshop by workshop personnel. No particular skill is required to take a reading and the lever application of the load does not call for careful or sensitive handling. They can be used in any position, in parallel or taper bores, and are not susceptible to damage by shock or vibration. Check plates for all hardness ranges, certified in the laboratories of the Vienna University, are available to enable the accuracy of the instrument to be tested at any time before practical use.

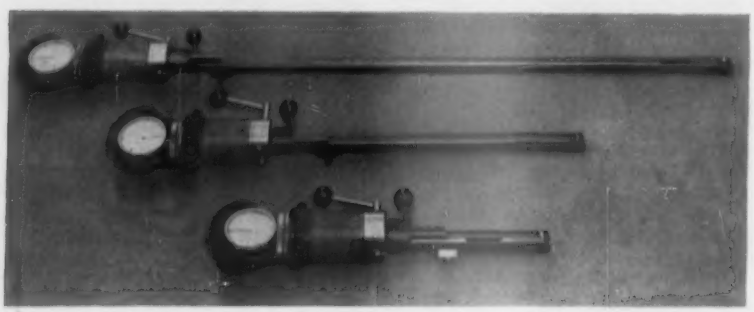
Starting with the instrument assembled with the appropriate load spring and indentor, and with the indentor withdrawn to its safety position, the procedure for taking a reading is as follows. The probe is introduced into the bore to the required depth and the lower lever is slid forward to raise the hinged pressure pad, arranged at 180 deg to the indentor, into contact with the bore. A hinged half-nut adjacent to the lever is turned in by a finger to engage a thread on the clamping element and the lever is then turned to load the pressure pad and lock the instrument in the bore.

Next, the upper lever is turned through 90 deg to bring the indentor from the safety position to the pre-load position in contact with the surface of the bore. The instrument is then set by rotating the dial, bearing the usual black, red and green Rockwell scales, until zero is indicated on the appropriate scale. Movement of the lever through a further 90 deg releases the spring load, which is transmitted to the indentor to make the impression. On the return of the lever to the pre-load position the Rockwell value can be read directly on the appropriate scale.

To extract the instrument from a bore after making a test it is merely necessary to turn the upper lever back to its original position in order to withdraw the indentor to its safety position, and then turn the lower lever through about 120 deg to release the clamping device. When it is necessary to change a spring unit, the protecting hood is unclamped and removed and, after turning the knurled upper nut, the dial can be withdrawn from its collet. The second nut is removed by means of a special claw spanner to release the spring unit which can then be drawn out of the body.

As the total movement of the pressure pad is insufficient to effect a clamping action in the larger bores within the range of the instrument, two detachable bridge pieces of different depth are provided. One or the other of these is hingedly attached to the probe and overlies the roller end of the pressure pad. Since the pressure pad roller is cylindrical and the bridge pieces are parallel, it follows that they engage the bore only at their extremities and thus, in conjunction with the foot of the indentor head, a three-point contact is established for clamping.

Similar loading and indicating means for direct reading on Rockwell scales are provided for the external hardness testers manufactured by the firm. These instruments, however, can also be supplied for use on Brinell (B.H.N.) or Vickers (D.P.N.) systems, but the provision of the corresponding measuring microscopes is entailed.



Instruments of three standard lengths enable tests to be made to depths of 36 in

CYLINDER LINER PRODUCTION

The Procedure Employed by Sheepbridge Stokes Ltd. to Ensure High Quality

TWO main factors must be observed in the production of high quality cylinder liners. First and, of course, fundamental, is precise metallurgical control to ensure that the castings are completely sound. Secondly, there must be close dimensional control during the cutting operations for imparting the desired form. Both factors have been closely studied over many years at the Chesterfield Works of Sheepbridge Stokes Ltd., an organization which has long specialized in the manufacture of centrifugally cast cylinder liners.

Fig. 1. Part of the centrifugal casting area at Sheepbridge Stokes Ltd.

In the centrifugal foundry, the main plant comprises six cupolas and more than 50 horizontal axis centrifugal casting machines, all laid out to give the maximum flexibility in production. The cupolas back on to the railway from which raw materials are delivered into bunkers immediately at the rear of the cupolas. The cupolas are arranged in pairs. In the foundry itself there are three tilting metal receivers, so positioned that each serves one pair of cupolas used alternately. Along the front of the melting section there is a ladle monorail with extensions at right-angles into the casting area, see Fig. 1. In this area the machines are arranged in groups of two lines with a "U" loop of monorail between them. At the rear of each line of casting machines there is a rail track on which four-wheel bogies operate as far as a pendulum conveyor that travels out of the foundry across an open space to the inspection department.

In general terms the cupolas operate as follows:—

Cupola	Output	Production
Nos. 11 & 12	5 ton/hr	Small piston rings and liners
Nos. 4 & 5	3 ton/hr	Small piston rings and liners
Nos. 6 & 7	3 ton/hr	Large piston rings and liners

For some of the production, the more highly alloyed irons are required. They include "Centrard" (a chrome/aluminium iron for nitriding) "austenitic iron" (a high nickel/copper/chromium iron), 33 per cent chromium (a high chrome iron) "Enduron" (a 16 per cent chromium iron) and D.T.D.485A (a high chromium molybdenum iron). These high alloy irons are melted in Stein and Atkinson rotary furnaces fired with creosote pitch. Each of these furnaces has a capacity of 1 ton of metal per hour.

As was said earlier, the layout has been planned to give maximum flexibility. The metal can travel in alternate directions, and if the load should consist of a large number of small castings only one cupola may be called upon. An average melt is 500 tons per week.

Very strict control is exercized over cupola operation. All the pig iron is analyzed, and all material charged into the cupola is weighed to conform with laboratory specifications. The cupolas are melting continuously, and are tapped into hot-metal receivers for temperature control and mixing. From the receivers, samples are taken for analysis at half-hourly intervals and for chill tests every ten minutes. Mechanical tests such as Brinell hardness, and tensile and En values are carried out in accordance with such specifications as BSS4K6 and D.T.D.485. For the smaller castings, the metal is tapped from the receivers into 2 cwt ladles suspended from the runway for distribution to the casting machines. For the larger castings, metal is tapped into 15 cwt ladles for distribution via another runway to six large casting machines.

Each casting machine, see Figs. 2 and 3, has a horizontal drive shaft powered by a D.C. variable speed motor. On the end of the shaft is a faceplate to

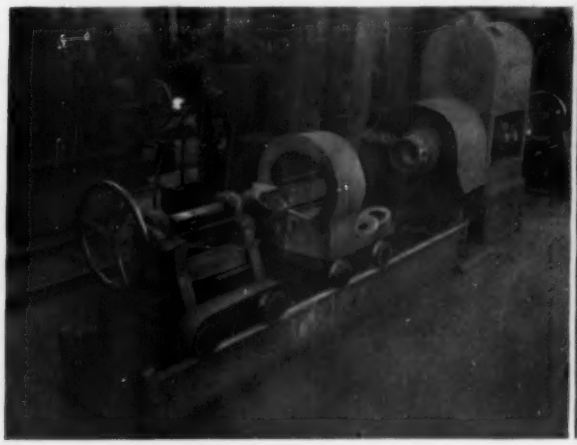


Fig. 2. A typical centrifugal casting machine

Fig. 3. Pouring a centrifugal casting

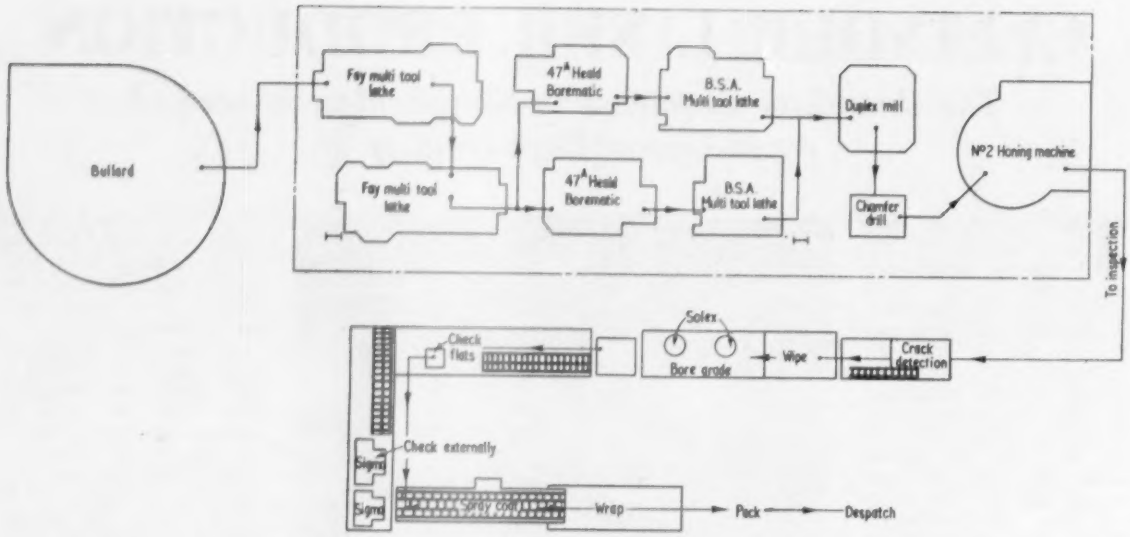


Fig. 4. Flow machining and inspection layout for castings produced in large quantities

which is bolted a cylindrical die holder finned and subject to a cooling from the outside by a low-pressure air blast. The cast iron die is flanged and of an outside diameter that will make it a tight fit in the holder when expanded by heat, a detail necessary for good thermal conductivity. On to the face of the die flange is pushed the circular door-plate which has a central hole of such a size that it controls the bore size of the casting. Next to the door-plate is added the catch-plate which has a dished rim and serves to retain the door-plate and catch excess metal; it is held in position by radially disposed pins driven from the inside outwards through the wall of the die holder. It is essential there should be a good fit between these parts to prevent metal penetration.

A pair of track rails on the ground, but slightly raised to give a comfortable working height, run in front of this spinning unit. Two trolleys, one carrying a movable guard and the other the pourer box, are mounted on these rails. The pourer box trolley has a handwheel at the rear, which turns a shaft mounted in two bearings and aligned to the centre of the die. From this shaft there projects at the forward end the pourer box and spout. The box itself is "D" shaped in plan with a long forward spout in line with the shaft and the box flat side; consequently when the box is turned towards this flat any metal runs out of the side of the spout exactly on the centre line of the shaft and die. By virtue of the carriage mounting the pouring box and spout may be advanced so that the latter is inside the die.

Before pouring the iron into the die, the die is coated on the inside with a die dressing to prevent the metal sticking to the die. The machine is set to give a linear peripheral speed on the casting of 1,200 ft/min. The metal carrier fills the pourer box with molten metal to a marker on the side, the upper limit of the casting mass really being regulated by the door-plate hole, since the bore cannot be smaller than this. The caster can now get to work while the carrier goes to the next machine. He advances his pourer trolley until the spout passes through the guard and is the full length of the casting; as it is of the weir type he can also remove the slag easily. There is considerable skill in pouring since the rate must be slow enough for the metal to be sufficiently chilled on striking the die to receive a centrifugal action; on large castings particularly, this temporary bore of cast metal must impart enough friction to further additions of metal to make them rotate. Indeed, it is the frictional effect which is the secret of the whole process: pouring too fast fails to make use of it; pouring too slowly provides a non-homogeneous casting.

Output of a typical casting by this method may be seen in relation to an actual case. A casting 7 in long × 2⅞ in bore, with an outside diameter 4⅛-3¾ inches and weighing 13 lbs, would be produced from one machine at the rate of 200 per day on a 9 hour shift.

Fig. 5. The complete machining sequence for a typical Sheepbridge Stokes cylinder liner, from the parted-off casting at the left to the finished liner at the right

Typical sizes range from the small at 44 mm o/d × 28 mm. i/d × 12 mm long to the large at o/d—30 in and 15 in long or o/d—22 in and 50 in long; the latter being produced on one machine at a rate of about 12 per day. All castings are, of course, tapered for extraction from the die. The allowances on the casting are ± $\frac{1}{32}$ i/d and ± $\frac{1}{16}$ o/d, although for piston ring pots this may be ± $\frac{1}{8}$ mm o/d and + $\frac{1}{2}$ mm − 2$\frac{1}{2}$ mm i/d.

Die changing is normally carried out at the end of each shift, although to suit production requirements, it may be necessary to change a die for a new size during the shift. All dies are reground every day and when worn machined out for larger diameters. A cast iron die usually produces 500-800 castings before machining is necessary.

The excellence of the floor arrangements will be readily understood when it is realized that, while the hot metal is brought up to the machines by monorail on one side, the castings are taken away by bogie from the opposite side. At the end of the bogie tracks is the pendulum conveyor travelling to the adjacent inspection department. The time taken for conveying the individual casting is 25 minutes, sufficient to ensure that the castings are cool enough to be handled by the inspectors.

Productivity is high. The foundry employs a total of approximately 200 men and of a total melt of 500 tons per week the yield of good castings, after parting off, is 70 per cent by weight. Dimensional control is aided by checking the first castings from dies, checking the dies and by providing the machine operators with gauges for the bore of castings. The castings are delivered as-cast to outside customers in approximately 40 per cent of cases and the balance to the Sheepbridge machine shop.

Before delivery to the machine shop, the castings pass through four separate preparatory divisions. These are inspection, flange grinding, parting-off and marking. The inspectors operate with standard "go" and "no-go" gauges for typical dimensional tolerances such as $\frac{1}{32}$ in on the o/d and $\frac{1}{16}$ in on the bore; they also make a visual inspection for soundness of casting. Flange grinding is carried out not only as a normal defrazing operation, but also as an accurate facing operation on the location flange where it has been added, or otherwise on a plain end of the pot to provide a square location for the machine shop jigs.

Fig. 6. The Bullard Multimatic machine for the first operations

Parting off is carried out on the end of the pot opposite to that ground and the shop for this purpose has an extremely good lay-out, including 16 Crowthorne Engineering lathes in line, equipped with carbide tipped tools for high output. Stencilling is used for marking off in a separate shop before the work goes to the stockyard adjoining the machine shop. Pendulum conveyors interconnect all these divisions, so that the apparent separation of the shops is misleading. In fact castings have the minimum of handling right from the spinning machines through the intermediate stages to the machine shop.

There are two principal Sheepbridge Stokes machine shops for the production of cylinder liners and rings. Between them they employ roughly 355 men, 60 per cent of whom are skilled, producing on the average, 20,000 liners per week, in all sizes.

No. 1 Machine Shop is 19,400 sq. ft in area, on one floor, and is well equipped, lit and ventilated. The characteristic production in it is that of large cylinder linings up to 44 in long with a 15 in bore which it is expected to increase shortly by a further range to a maximum of 72 in long with a 20 in bore. The plant includes centre lathes by Crowthorne, Lang, Dean Smith & Grace; honing machines by Kitchen & Wade and by Gehring (20 in bore × 84 in stroke); internal planetary and external and plain grinders by Churchill; Ward combination turret lathes; Potter & Johnson autos; B.S.A. multi-tool lathes; Churchill-Fay multi-tool lathes, etc. In most cases these are grouped according to the machine type.

Fig. 7. Turning the liner water space on a Churchill-Fay multi-tool lathe

When considering No. 2 Shop, it is necessary to appreciate that because it deals with the smaller liners associated with the automobile industry, longer production runs result and it has been possible for a considerable area to be allocated to continuous lines. The floor space is very slightly greater than that of No. 1 Shop and the equipment is similar except that it consists of smaller capacity machines. In this case the continuous lines are of special interest.

A typical lay-out of machines in No. 2 Shop for line production of car and light lorry cylinder liners is seen in plan in Fig. 4. The sequence of operations, see Fig. 5, is as follows:—

Stage 1: Part turn skirt and machine bore on Bullard Multimatic 8-spindle vertical turning and boring machine.
Stage 2: Rough and finish profile on Churchill-Fay multi-tool lathes.
Stage 3: Fine bore on Heald 2- and 3-spindle Borematics.
Stage 4: Fine turn on B.S.A. multi-tool lathes.
Stage 5: Mill flats on Cincinnati duplex (horizontal) miller.
Stage 6: Chamfer bore on converted two-spindle driller.
Stage 7: Hone the bore on Kitchen & Wade 16-station honing machine.
Stage 8: Inspection—magnetic crack detection.
Stage 9: Inspection—check bore and finish.
Stage 10: Inspection—grade and stamp.
Stage 11: Inspection—check all external dimensions on Sigma multi-dimensional machine.
Stage 12: Grease, wrap, pack.

The Bullard Multimatic, Fig. 6, has eight vertical spindles suspended from a circular frame over a rotatable work table and in this case is set to carry out three operations in duplicate. As it is a dead-loading machine the work is chucked on two dead stations, positions 1 and 2; operation one is carried out by spindles 3 and 4, operation two by spindles 5 and 6, and operation three by spindles 7 and 8,

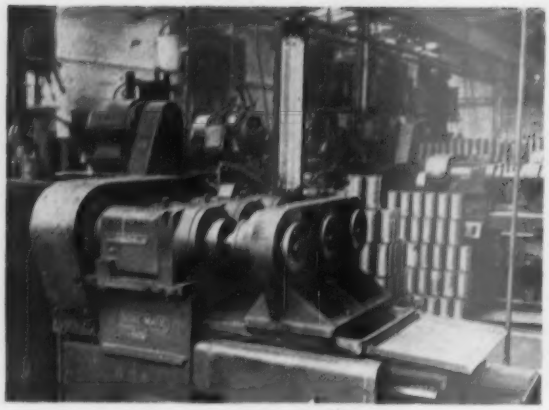


Fig. 8. Liners set up for fine boring on a Heald Borematic

so double indexing is necessary. The three-jaw concentric chucks are turned *in situ*, ensuring concentricity with the machine spindle and their tapered jaws, reaching half the height of the work, are manually operated by key and screw.

Castings are brought by pendulum conveyor under cover and shipped onto an inclined roller conveyor delivering to stillages on the machine shop floor where they are moved up to the machines by a Morris hand truck. After the castings are mounted in the chucks at stations 1 and 2, the machine is double indexed. At stations 3 and 4 each casting is rough turned on the skirt and rough machined in the bore for the same distance, leaving 0·030 to 0·035 in on both diameters. The skirt, of course, only occupies perhaps a quarter of the length of the casting, but this procedure is adopted to avoid distortion and also because in any case the chuck arrangement would interfere with machining the full length outside.

On the next two spindles the operation consists in taking out the full length of the bore during which a rapid traverse is used on the part already part-machined followed by a slow traverse through the uncut remainder. The third operation reams the bore and skims the skirt leaving on the required diameter −0·018 to −0·022 in on the former and +0·020 to +0·025 in on the latter. The turning tools are double mounted from opposite sides and in form are the standard straight-knife type; boring tools are the standard cranked flat top in form with a 3 degree front rake. Boring is carried out at 150 ft/min and finishing at 180 ft/min on iron which is usually in the order of 275 Brinell. Duckham soluble oil is used as a coolant.

Two Churchill-Fay multi-tool lathes are used, one for roughing, and the other for finishing the same dimensions, with a somewhat similar layout of tools. One of these machines is shown in Fig. 7. These include two tool boxes, one at the front and one at the rear. The front box contains four tools, two for turning the flange to size and two for machining the parallel part of the water space. The back box which is fed in almost simultaneously with the front, also has four tools, two for facing the flanges and two for the radius from the water space parallel to the flanges. Machining allowances on the bore and skirt are the same as at the previous operation, but the overall length is true within +0·050 in of the finished size and the length between the flange faces to +0·025 in, while the water spacing is finish turned to a tolerance of ±0·010 in. Work is mounted on an air expanded mandrel constructed of a split sleeve in three segments operated by an internal cone on a drawbar. This mandrel rejects incoming work which is 0·005 in small and the operator inspects his finished material with "go" and "no-go" snap gauges for the flange diameter which is −0·003 in on the finished size.

At the third stage on the Heald Borematics, Fig. 8, the pots are mounted three at a time in a jig on a sliding head which is traversed towards the three horizontal spindles pneumatically. The part-machined castings are fed into the jig from the rear and located on the shoulders of the two flanges and also the skirt and rear faces, by the pressure of a nut closing the back of the jig cavity. A 10 mm Solex air comparator is permanently fixed on the machine with dual controls, respectively for setting the tool height and providing a plug gauge for determining the finished bore size. This is used by the operators as a matter of course, except in those cases where blind men carry out this operation, which they do with outstanding success, but with the assistance of setters who use the gauge. In this case the bore is taken down in one operation from −0·018/−0·022 in to −0·001/−0·015 in on the finished size. Material which is oversize on the outside will not, of course, go in the jig.

At the next stage (the fourth) on B.S.A. multi-tool lathes, Fig. 9, the finished profile is produced on the skirt o/d. Work is mounted on a pneumatically expanded mandrel attached to the headstock at one end and at the other on a tapered roller on the tailstock, which acts as a check on the bore diameter. The tools are gang assembled in two standard tool boxes, one behind and one in front of the work.

From the front tool box the lead diameter is turned to a tolerance of 0·005 in, the skirt diameter is turned to a tolerance of 0·001 in, and an external chamfer is formed on one end. From the rear tool box the inner face, the skirt end face and the back face are machined and an undercut is formed.

Very careful checking of the work by the operator takes place after these operations. A Solex gauge records the skirt o/d. Horseshoe "go" and "no-go" gauges are used on the lead and undercut diameters. A Mercer height gauge shows the distance between the flanges, and a length gauge provides the

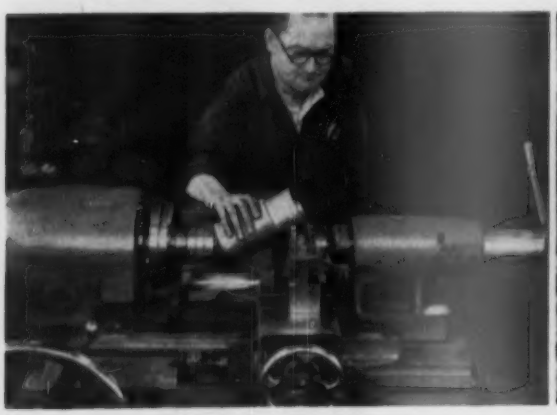


Fig. 9. B.S.A. multi-tool lathe for finish turning the liner skirt

Fig. 10. Cincinnati duplex machine for milling flats on the liner

measurement between the skirt face and back face, which determines overall length.

The next stage could be somewhat commonplace, but in fact to secure higher productivity and accuracy an interesting lay-out has been developed. Four equidistant flats are milled on the periphery of the two flanges. In principle this is done by using end mills of sufficient diameter to span both flanges simultaneously, with two at work at the same time on opposite sides. For this purpose a Cincinnati Duplex horizontal miller, Fig. 10, is used. Twin horizontal arbors are mounted on opposite sides of a hydraulically operated feed table traversing in such a way that work is passed between cutters attached to the arbors. The part-machined liner is mounted vertically on an upright air-expanded split mandrel attached to the feed table. When the table is forward and the mandrel is on the entry side of the cutters, a trigger control of the air supply is clear of a control stop on the machine casing so that the air supply is off, the mandrel closed, and the work easily removable. As the feed table brings the mandrel up to the cutters, the trigger is operated by the stop, the air is switched on, the mandrel expanded and the work firmly gripped.

The traverse of the table takes the work through the cutters and removes the metal for the first set of opposite flats: to ensure that the second pair of flats are at right-angles to the first, two guide bars are attached to the air jig baseplate on either side of the mandrel. During the first operation, the work stands on top of these guide bars, but for the second pair of flats it drops between the guide bars since the pair of flats already machined locate accurately within them. This location prevents circumferential movement of the work during milling and ensures the second set of flats are at right-angles to the first. Preset stops secure a slow traverse through the cutters and quick return.

For this operation the cutter teeth are of carbide attached to mild steel pads which are inserted in slots in the actual segmental wheel; there is hardly any top rake and the front clearance is 5 degrees. Tolerances on this finished work are measured radially from the centre to the centre of the flat and have to be with $\pm 0{\cdot}004$ in. Apart from the location pads on the jig acting as gauges for oversize, the operator puts approximately 5 per cent of the production through a Mercer clock gauge.

The sixth stage provides an internal chamfer at each end of the liner, for which a converted two-spindle vertical driller, shown in Fig. 11, is used. The tool rather like an endmill, consists of six carbide teeth inserted vertically in the head of a "mushroom" type body, extended so that the stem may carry at the lower end a location roller running freely on the stem on ball-bearings but with an o/d strictly to the liner bore size less 0·002 in. This location roller is retained in position by a securing plate attached by a nut. About the cutter head is a hollow collar which acts as a guard. Work is mounted on a jig consisting of an air-expanded split mandrel, the base-plate for which is hinged to a mounting. The air system simultaneously collapses the mandrel and tilts it at this pivot, so as to speed up removal and positioning the liners for chamfering. It is clear that this arrangement ensures chamfer concentricity and alignment of great accuracy, and itself acts as a gauge for internal dimensions especially undersize.

At the seventh stage honing the bore is carried out on a 16-station Kitchen & Wade machine, see Fig. 12. The liner is mounted in a ring on the table with the skirt uppermost, so that it is held in position by an air-operated fork brought to bear on a bush mounted over the skirt and resting on the flange. The torque bar which applies the drive to the honing stones is also used as a knock-off, striking the air control lever and so releasing the liner from the fork clamp and indexing the table in one action. Two operations control two action stations: respectively, the removing and loading station, and the honing station; on the rotatable work table these are seven stations from one another, the remaining nine carrying work after honing up to the removing position. The honing operator applies a fixed number of strokes at a given pressure to each liner. A second operator checks the bore of liners before loading them on the appropriate seat on the work-table and adding the bush; he also checks each liner after honing with the aid of a Solex air-operated plug gauge.

After the machining, the liners pass into the hands of the Inspection Department staff, who are located at stations alongside the production operations in the case of the mass produced items under consideration. These inspection stations are in a logical sequence receiving work at one end and passing it to packing at the other.

Final inspection starts with crack detection on a Fel electric machine. This is followed by a visual investigation for metallurgical soundness, and surface finish, especially in the bore. Then follows sizing the bore with a Solex air-pressure gauge. The total machining tolerance is 0·0011 in, but the liners are graded into three tolerance groups. No. 1 for tolerance 0·0000 to 0·0004, No. 2 for tolerance 0·0004 to 0·0008, and No. 3 for 0·0008 to 0·0011 in, the appropriate grade is stamped on the top flange by a small hydraulic press. This inspection stage is shown in Fig. 13.

After this the liner is passed to an inspection apparatus which, at one pass, registers whether nine external dimensions are correct, and if not, which are undersize and which oversize. This is the Sigma nine-point multi-dimensional inspection machine shown in Fig. 14. In outward appearance the Sigma assembly has three constituents: a base containing a horizontally sliding table on which is mounted a vertical mandrel for receiving work; this table traverses work through an aperture in the second component, a glass-fronted cabinet in which are nine pointers associated with contactors contained within electronic units; over-head

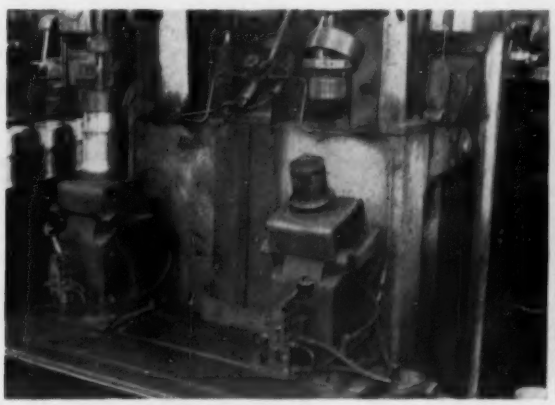


Fig. 11. An adapted two-spindle drilling machine for chamfering the liner

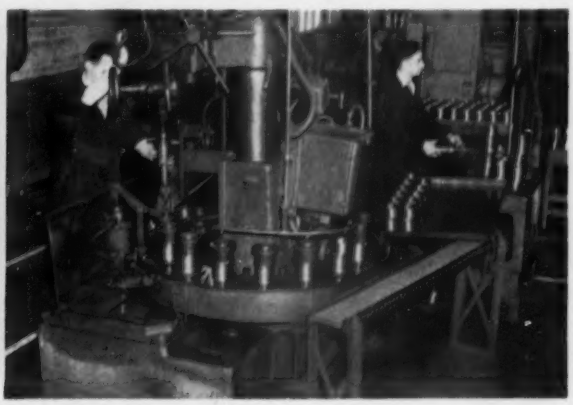


Fig. 12. Kitchen and Wade honing machine for finishing the liner bores

Fig. 13. The inspection station for checking liner height, skirt concentricity, skirt diameter and bore diameter

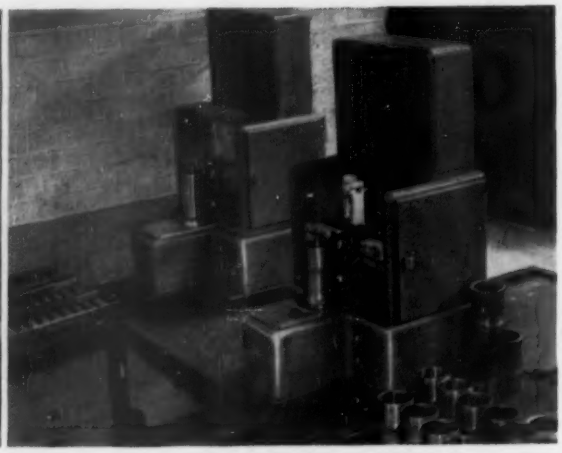


Fig. 14. Sigma multi-dimensional inspection machines for checking nine external dimensions simultaneously

is the third member, a panel bearing a diagram of the article being measured together with a row of nine red lights, a row of nine amber lights and one green light. From each of the nine lights is an indicator line pointing to the part of the liner diagram to which it refers.

Operation may be continuous, with the work carried through the pointers and back to a dwelling position for re-loading before automatically continuing; or it may be subject to a foot control which passes the work in and returns it for each operation of a pedal. If the green light shows, all dimensions are to size: if any of the nine red lights show that particular dimension is undersize; if any of the amber lights show, the measurement indicated is oversize. The Sigma machine is set to accept liners within a tolerance of 0·001 inches on the outside diameter and 0·001 inches between the flange faces (where the top limit is +0·0005 and the bottom −0·0005 inches). Liners which do not fall within these limits are rejected.

The contacts on the pointers are set by micro screws adjustable to within 0·0001 in, which are checked every day. The operating rates of the traverse table is 18 return strokes a minute and each liner is mounted three times at approximately 120 degrees to the previous position. On the liners under consideration the Sigma inspection machine records the correctness or otherwise of the following dimensions: (1) lead diameter, (2) and (4) skirt diameter, (5) undercut diameter, (3) concentricity, (6) flange diameter (bottom skirt), (7) top flange diameter, (8) distance between flange faces, (9) overall length.

Immediately after checking on this machine, those liners which are satisfactory (the vast majority) are placed on one of three sets of roller conveyor tracks corresponding to the bore grades 1, 2 and 3, already determined and marked on them. While on these conveyors, the liners pass under an oil spray in an enclosed cabinet; at the exit end of this they are wrapped in such a way that an enclosed label is visible indicating the bore grade. The cylinder liners are now placed in boxes, finished and ready for despatch to the customer.

Although there are many other parts of these cylinder liner shops with equally interesting machinery and inspection methods, the above is sufficient to show that accuracy at Sheepbridge Stokes is achieved by good casting, dimensional control by jigging and sizing at each operation, and subsequent inspection with accurate apparatus.

INSTITUTION OF MECHANICAL ENGINEERS

Forthcoming Meetings of the Automobile Division

The following meetings will be held during November:—

LONDON

Tuesday, 8th November, 5.30 p.m., at 1, Birdcage Walk, Westminster, S.W.1. Paper: "Disc Brakes," by F. G. Parnell (Member) and F. J. Bradbury, (Associate Member).

BIRMINGHAM CENTRE

Tuesday, 22nd November, 6.30 p.m., at James Watt Memorial Institute, Great Charles Street. Paper: "Some Aspects in the Design and Performance of Small Diesel Engines," by B. W. Millington, (Associate Member) and M. H. Howarth, (Associate Member).

COVENTRY CENTRE

Tuesday, 1st November, 7.15 p.m., at Grosvenor Room, Leofric Hotel, Coventry. Address by the chairman of the Automobile Division, Dr. C. G. Williams, D.Sc.(Manch.) entitled "Some Experiences of Automobile Research."

Graduates' Section

Tuesday, 15th November, 7.30 p.m. at Craven Arms Hotel, High Street, Coventry. Film Evening.

DERBY CENTRE

Monday, 14th November, 7.15 p.m., at Midland Hotel, Derby. Paper: "Fatigue of Metals," by Professor A. E. Pope.

LUTON CENTRE

Monday, 14th November, 7.30 p.m., in the Assembly Hall, Luton Town Hall. Paper: "Disc Brakes," by F. G. Parnell, (Member) and F. J. Bradbury (Associate Member).

NORTH-EASTERN CENTRE

Wednesday, 16th November, 7.30 p.m., in the Chemistry Lecture Theatre, The University, Leeds. Paper: "The Work of the Motor Industry Research Association," by A. Fogg (Member).

NORTH-WESTERN CENTRE

Tuesday, 15th November, at 7.15 p.m., at Grosvenor Hotel, Chester. Address by the chairman of the Automobile Division, Dr. C. G. Williams, D.Sc.(Manch.) (Member), entitled "Some Experiences of Automobile Research."

SCOTTISH CENTRE

Monday, 14th November, 7.30 p.m., at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow. Joint Paper with the Institute of Metals, "Some Problems with Materials for Gas Turbine Engines," by Kenneth Metcalfe, B.Sc.

Monday, 21st November. Paper: "Jet Engines: Some Aspects of their Design, Operation and Manufacture" by A. W. Vicker, M.Sc.

WESTERN CENTRE

Thursday, 24th November, 6.45 p.m., at Royal Hotel, Bristol. Paper: "Disc Brakes," by F. G. Parnell (Member) and F. J. Bradbury (Associate Member).

THE FIAT 600

Part II: Details of the Mechanical Components of the Chassis

SOME impressions of the body-chassis structure of the 633 cm³ Fiat car, as exhibited at the Geneva Show for the first time, were given in the April 1955 issue of the *Automobile Engineer*. Further details are shown in the illustrations of the coachbuilders' chassis drawing and the diagrammatic sketch of the body assembly in the pages that follow. Evidently, in the design of the structure, considerable attention has been devoted to the provision of a chassis suitable as a basis for coachbuilt vehicles. This is a particularly good feature since, as a result of the almost universal adoption of chassis-less construction by European manufacturers of quantity produced cars, there are few modern chassis from which the coachbuilders, of whom there are many of high repute in Italy, can make a choice.

SPECIFICATION

TRANSMISSION: Single dry plate clutch, 6 7/16 in diameter. Four speed gearbox with synchromesh on top, third and second. Ratios: top 0·896:1, third 1·333:1, second 2·055:1, first 3·385:1, reverse 4·275:1. Final drive unit between the engine and gearbox. Ratio of spiral bevel gears 8:43. Pot type universal joint at inboard ends of half shafts, rubber coupling at outboard ends.

SUSPENSION: Rear, triangulated link on each side, with coil springs. Front, double transverse link on each side, with the traverse leaf spring forming the lower pair of links. Telescopic hydraulic shock absorbers, 1 1/16 in bore, front and rear.

STEERING: Worm and sector giving a ratio of 2:26. Wheel 15 3/4 in diameter, 2 1/8 turns from lock-to-lock. Turning circle 28 ft 6 1/2 in diameter.

BRAKES: Two leading shoe hydraulic front and rear. Drum diameter 7 1/16 in, shoe width 1 3/16 in. Shoe area 66·8 in². Hand brake mechanically actuated, acting on the front end of the gearbox layshaft.

WHEELS: Disc type with 3 1/2 in rims. Tyres 5·20—12, pressure front 14 1/2 lb/in², rear 22 1/2 lb/in².

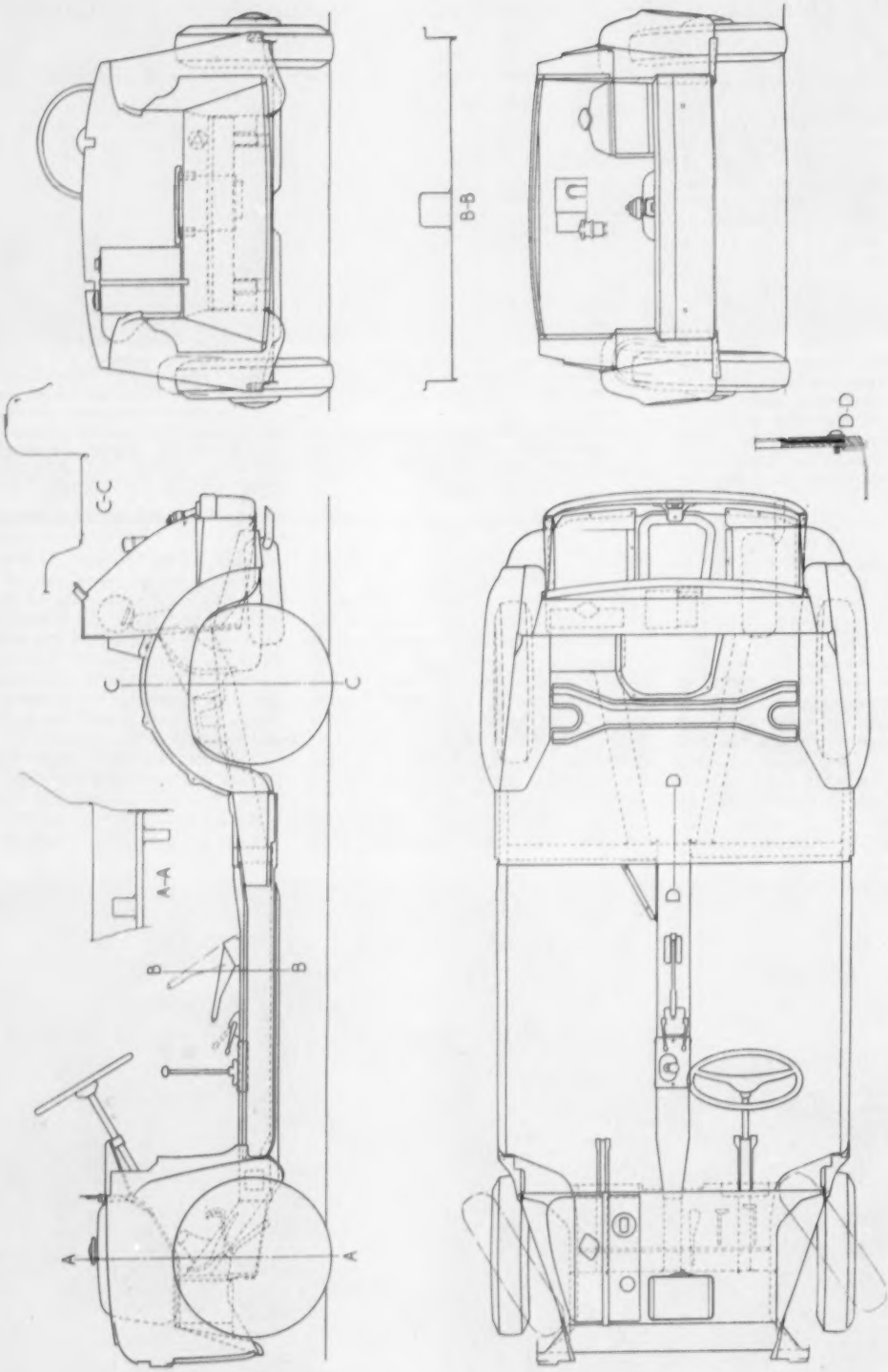
DIMENSIONS: Wheelbase 6 ft 6 3/4 in. Track: front 3 ft 9 3/16 in, rear 3 ft 9 1/16 in. Ground clearance, laden, to clutch bell-housing 6 1/16 in. Overall length 10 ft 6 1/16 in. Overall width 4 ft 6 1/16 in. Overall height, unladen, 4 ft 7 3/16 in. Frontal area 15·5 ft². Dry weight 1,234 lb. The front: rear weight distribution with four passengers and 66 lb of luggage, 44 lb front and 22 lb rear, is 0·407:0·593. Engine dry weight 154·3 lb. Gearbox and differential weight 72·7 lb. Clutch weight 5·7 lb.

As can be seen from the coachbuilders' chassis drawing, it is a relatively simple matter to fit body panelling of almost any practicable style on to the basic structure of the new Fiat car. Moreover, alterations to the wheelbase can be effected readily, because of the independence of the front end assembly from that at the rear, which comprises the engine, transmission and suspension. The coachbuilder is even left with complete freedom to design his own body sills, since the basic structure includes only the inner panel of each sill. This has been made practicable by the incorporation of a central, box-section longitudinal member between the toe and heel-boards. Not only does this member stiffen the basic frame sufficiently to enable the chassis to be handled readily for delivery to the coachbuilder, but also it totally encloses the controls to the engine and transmission, so that they are well protected from abrasive and corrosive foreign matter. In addition, there is little doubt that, to those who wish to mount drop-head types of bodies on the chassis, the additional strength afforded by this member is a useful feature.

Apart from this central longitudinal member, the main structural components are as follows. At the front, the dash-sides and wheel valance panels act as forward extensions of the sills, while at the back, the extensions on each side are formed by the inner and outer rear quarter panels. A strong cross member at each end is combined with the body panelling; the member at the rear is bolted-on to facilitate installation and removal of the engine.

The intermediate cross members include the toe-board and dash assemblies, the heel-board, and the rear bulkhead separating the saloon and the engine compartment. Another cross

A noteworthy feature of the Fiat 600 is the amount of space available for the passengers, despite the short length of the vehicle



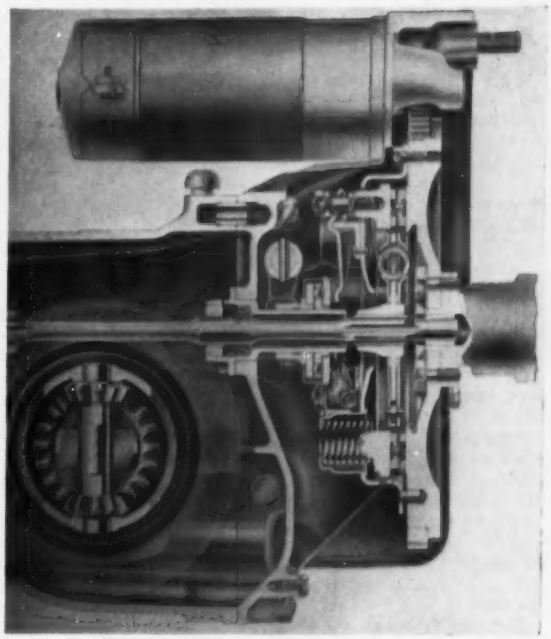
ARRANGEMENT OF THE FIAT 600
Wheelbase 6 ft 6¾ in. Track: front 3 ft 9⅞ in., rear 3 ft 9⅞ in

member is formed by a top-hat section spot-welded by its flanges to the floor immediately behind the rear seat. At its ends, this member supports the rear springs and shock absorbers. The inward extending links of the rear suspension are pivoted on brackets attached to the arms of a Y-shaped extension of the central longitudinal member, and the forward extending links are pivoted in a similar manner on the box-section cross member formed at the heel-board. Also carried on the arms of the Y-extension are the sandwich type mountings on each side of the gearbox.

At the front, the suspension loads are taken from short longitudinal structural members to the toe-board, which has a doubling plate spot-welded to it. There are two of these longitudinal members, one on each side. Each is of top-hat section spot-welded by its flanges to the lower face of the toe-board. As viewed from the side, this member is of triangular shape, so that it fits the slope of the toe-board ramp in such a manner that its lower edge is horizontal. This edge carries the bolted-on bracket that secures the transverse leaf spring; the pivot pin forging of the upper transverse wishbone link of the suspension system is bolted to the side of the longitudinal member. The employment of the transverse leaf-spring arrangement has obviated the need for a cross member between the suspension units on each side, and thus has led to an appreciable saving in weight and cost.

Clutch and gearbox

A single dry-plate type of clutch, manufactured by Fiat, is employed. It is of the sprung-centre type and is of conventional layout. The friction facings are of Raybestos WR7 and are $6\frac{3}{4}$ in outside diameter by $4\frac{1}{4}$ in inside diameter. Their total area is 26·85 in^2. Six pressure springs are fitted; their load in the assembled condition is 407·8 lb. A ball thrust bearing is employed in the withdrawal mechanism. This is unusual in such a low priced car, but is undoubtedly a desirable refinement. With so small an engine, the less the friction in the thrust bearing, when loaded immediately before starting off from rest, the better it is from the point of view of the engine idle speed setting.

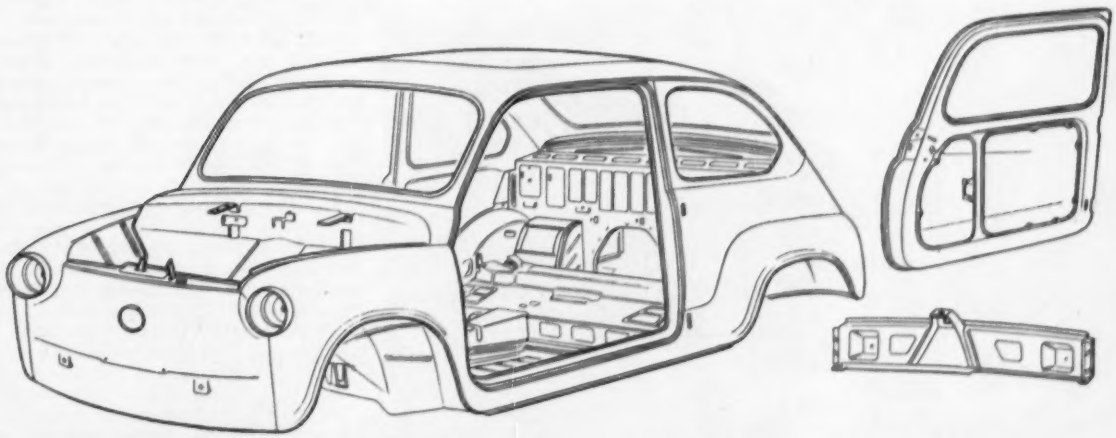


A ball thrust bearing is employed in the clutch actuating mechanism

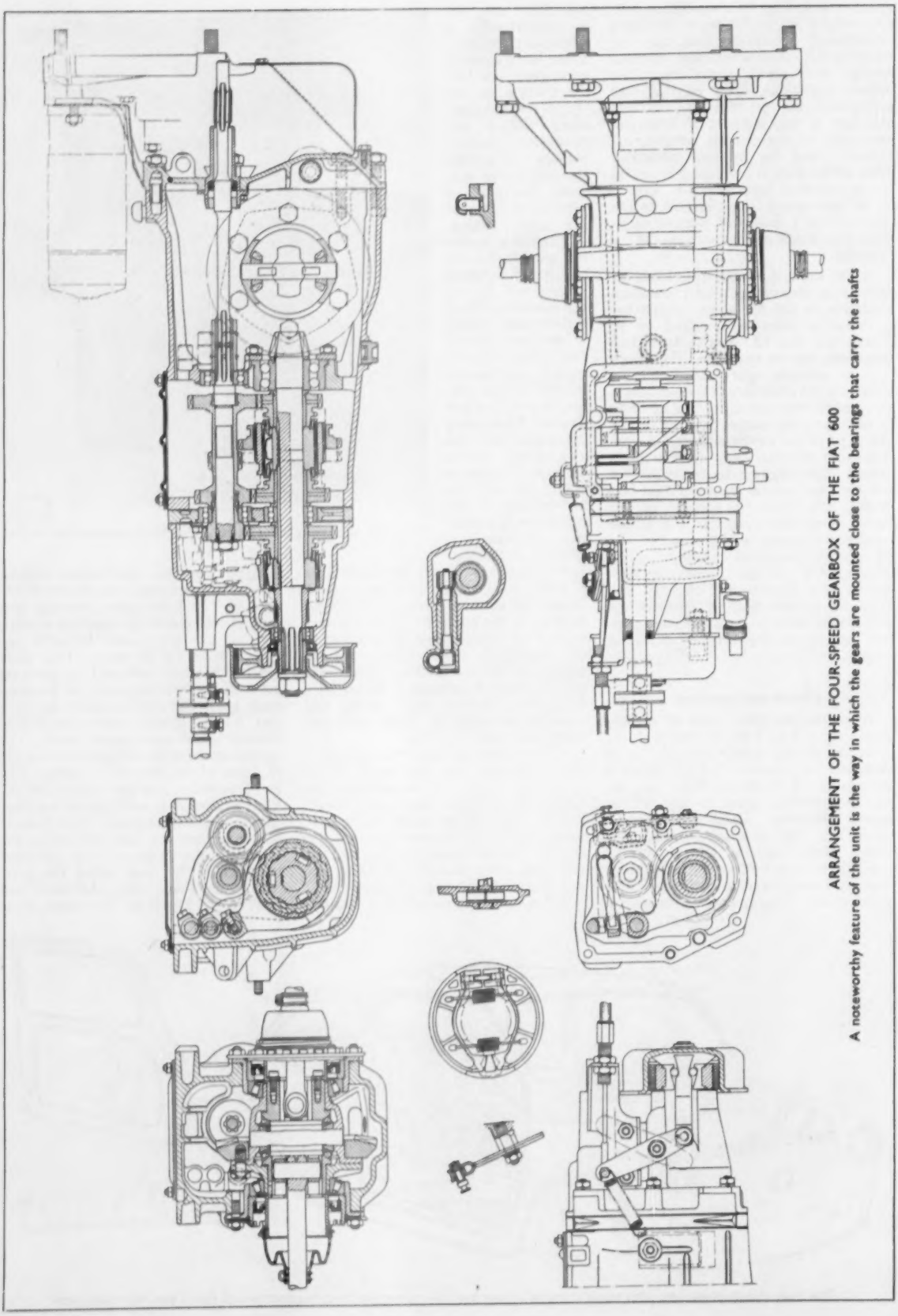
The whole assembly comprising the clutch and flywheel is enclosed by an aluminium alloy bell-housing bolted to the rear end of the final drive casing, and located by two 12 mm diameter tubular dowels. This casing is integral with the gearbox. Four 12 mm diameter bolts secure the bell-housing to the crankcase, and positive location is effected by tubular dowels through which the lower pair of bolts, one on each side, are passed. Dowels of tubular form are employed because of the relatively large diameter needed to afford adequate location in the aluminium alloy. Their ends are tapered to form a lead-in. The lower part of the bell-housing is closed by a bolted-on, pressed steel cover, and another pressing is fitted over an inspection port at the top.

A four-speed, all indirect, gearbox is employed and the top speed is an overdrive ratio. Synchronizers are fitted for second, third and fourth speeds. The weight of the whole unit, including the differential assembly, is 69¾ lb. The oil capacity of the gearbox and final drive unit is 2·72 pints, and S.A.E.90 E.P. lubricant is specified.

As is to be expected in a gearbox designed for the rear engine layout, some unconventional features are incorporated. To obtain quiet running with the indirect gears, the bearings at each end of the main and layshafts are spaced only $5\frac{7}{16}$ in apart. This close spacing has been effected by carrying between the bearings only the constant mesh gears and synchronizers for third and fourth speeds, with the sliding bottom speed gear round them. The second speed train and synchronizer are in front of the forward bearing. The employment of this layout places all the gears as close as possible to the bearings that support the shafts. This reduces to a minimum the shaft deflections and therefore the noise due to incorrect meshing of the teeth when the gears are under load. An additional ball bearing is fitted in the nose piece



The body-chassis structure, with views showing a door and the removable cross member which forms the rear skirt panel



ARRANGEMENT OF THE FOUR-SPEED GEARBOX OF THE FIAT 600

A noteworthy feature of the unit is the way in which the gears are mounted close to the bearings that carry the shafts

extension. It supports the front end of the layshaft, on to which is splined a transmission brake, actuated by the hand brake control.

An 11 mm diameter shaft transmits the drive from the clutch through the final drive housing to the primary shaft in the gearbox. It is increased to 17 mm diameter at the front end, where the centre-plate assembly of the clutch is splined on, and also at the rear end, where it is splined into the sleeve coupling that connects it to the primary shaft. The diameter of the shaft is also increased to 17 mm at an intermediate station, where it is carried in a sintered hard bronze bush.

This bush is housed in the front end of a flanged sleeve which is spigoted into and extends through the front wall of the bell-housing. Behind the phosphor bronze bush, a lip type oil seal is fitted in the sleeve. It bears on the 17 mm diameter portion of the shaft to prevent lubricant from passing into the bell-housing. Lubrication is effected by oil splashed in through a 3½ mm diameter hole drilled radially in the top of the sleeve to allow the lubricant splashed off the crown wheel and differential assembly to pass into the space between the bush and the oil seal. The portion of the sleeve in the bell housing carries the clutch withdrawal thrust-bearing assembly.

The sleeve coupling that connects the splined ends of the clutch shaft and mainshaft is retained by two circlips. These circlips are fitted in grooves around the outer periphery of the sleeve coupling and their ends are bent inwards to pass through radial holes in the sleeve to register in another two holes, one in each shaft. This axially locates the sleeve and the clutch shaft.

The inner race of the ball bearing carrying the mainshaft is retained between this coupling sleeve and a shoulder on the shaft. Its outer race is housed in a 47 mm diameter hole in the intermediate wall separating the final drive casing from the gearbox. This race is allowed a limited amount of axial float in its housing, since positive location of the mainshaft assembly is effected at the front ball bearing.

All gears are of a material equivalent to En 352. The first, third and fourth speed mainshaft gears are formed integrally on a sleeve. This sleeve is assembled over the front end of the shaft and slid rearwards until a splined collar round the shaft seats in the internally splined counterbore in the rear end of the sleeve—these splines transmit the drive from the shaft to the sleeve. Then another sleeve, on which is formed the second speed gear, is assembled over the front end of the shaft and splined into a counterbore at the front end of the first sleeve.

The inner race of the ball bearing that locates the mainshaft assembly is carried on this 25 mm outside diameter second sleeve and is clamped between the second speed gear and the front end of the first sleeve. Its outer race is flanged and is in a 52 mm diameter hole in the rear wall of the box. The flange seats in a counterbore round this hole and is clamped in position by a plate bolted to the rear face of the box. The whole assembly, comprising the inner race and the two sleeves is retained by a nut, locked by a tab washer, on the front end of the 17 mm diameter, En 100C shaft.

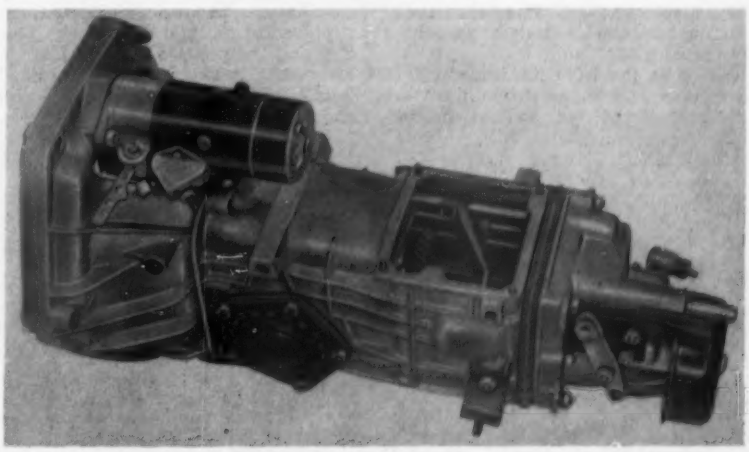
The crown wheel pinion is formed integrally on the rear end of the layshaft, which is of an alloy steel suitable for case-hardening. Behind it is the two-row bearing that locates the layshaft assembly. Interposed between the inner race of this bearing and the crown wheel pinion is a distance ring to clear the fillet between the shaft and the pinion. The inside diameter of the bearing is 1 in and its outside diameter is 2⅝ in. Its flanged outer race is assembled from the final drive casing end into its housing in the rear wall of the box. The flange is retained in a counterbore round the housing by a plate secured by 9 mm diameter studs to the rear face of the casing.

Clamped between the inner race of this bearing and the ball bearing in the front wall of the box are two flanged bushes, which carry the constant mesh gears for third and fourth speeds, and the centre component of the synchro-unit for these gears. An unusual feature of the design is that these bushes, as well as that for second speed, on the other side of the bearing in the front wall, are of a material equivalent to En 532, as also are the gears. All three bushes are identical; they are 1⅜ in long by 1·2598-1·25905 in outside diameter by 0·984 in inside diameter. Doubtless, the reason for the employment of hardened steel instead of phosphor bronze bushes is to minimise the rate of wear and thus to ensure quiet running throughout the normal life of the vehicle. The bearings are lubricated through holes drilled radially from between the teeth of the gears.

Three slots, 120 deg apart, are machined radially in the centre component of the synchro-unit, which, of course, is splined on to the mainshaft. They house the 10 mm wide detent springs. These springs are of the leaf type, bent to form a top-hat section with a dimple in its crown, to register in the detent groove in the En 352 sleeve. The edges of the flanges of the top-hat section are turned up and bear against the tongues of the synchro-cups, which project into the ends of the grooves that house the springs. The cups are of Biak metal No. 2, the mean diameter of their conical faces is 1·6 in, and the angle of these faces is 7 deg 30 min.

When the sleeve is moved axially to engage a gear, it carries with it the detent springs, the hairpin shaped ends of which bear against the ends of the tongues on the appropriate cup. Thus, the cup is moved into engagement with the cone. If the two components are not synchronized, the cup rotates until the clearance of the tongues in their slots in the centre component is taken up. This places the splines round the cone ring out of alignment with those of the sleeve and so baulks further movement. The ends of the splines of both components are chamfered so that when synchronization has been effected, the splines in the sleeve ride through those on the cup and slide into engagement with those machined round the boss of the gear. Splines are also machined on the outer periphery of the sleeve to carry the sliding first speed gear.

The bearing in the front wall of the gearbox is 1⅜ in inside diameter by 2⅛ in outside diameter. Its outer race is allowed a limited amount of axial float in its housing, since the assembly is located by the rear bearing. The En 32 bush that carries the second speed gear is splined on to the portion of the shaft that extends forward of the ball race. In front of this is the synchro-unit, which is similar to that already described for the third and fourth speeds, except that, because it serves only one gear, its three detent springs are of hairpin instead of top-hat section. To prevent the detent springs from moving forward out of their slots, a steel thrust washer is spigoted on the



A transmission brake is mounted on the rear extension of the gearbox

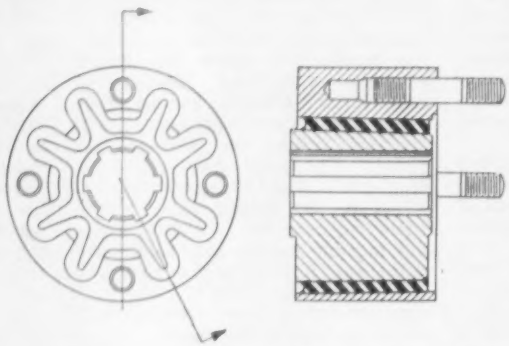
rear end of the speedo gear, which is between the centre component of the synchro-unit and the inner race of the ball bearing that supports the front end of the shaft. This bearing is $\frac{3}{4}$ in inside diameter by $1\frac{3}{4}$ in outside diameter; its outer race is not positively located axially in its housing.

The whole assembly, comprising the bearings, gears and synchronizers, is pulled against the crown wheel pinion by a self-locking nut on the end of the shaft. A baffle disc is fitted between the ball bearing that carries the front end of the shaft and the lip type oil seal forward of this bearing. This disc is clamped between the inner race of the bearing and the brake drum hub, on which the seal bears. Its function is to prevent unduly large quantities of oil passing forward and flooding the seal.

As can be seen from the illustration of the gearbox, the shoe assembly of the brake is carried on the forward extension of the casing. The brake is mechanically operated and is of the one-leading and one-trailing shoe type, with a simple roller-and-wedge type actuating mechanism. Its drum diameter is $4\frac{1}{2}$ in and the friction lining width is 1 in. The reason for mounting the hand brake on the layshaft in this manner is, of course, simplicity of control.

A $\frac{5}{8}$ in diameter En 352 spindle carries the reverse idler gear, in which is pressed a sintered bronze bush. One end of the spindle is carried in the front wall and the other in a boss on the side of the box. The idler comprises two integral gears, with a channel machined between them for the selector fork. One gear meshes with the sliding gear on the sleeve of the synchronizer for third and fourth speeds, and the other meshes with the intermediate of the three gears on the mainshaft cluster. Details of all the gears are given in the accompanying table.

The three 14 mm diameter selector rods are housed horizontally in the opposite side of the box to that in which is the reverse idler. They are parallel to one another with their axes in a vertical plane, and their ends are carried in the front and rear walls of the box. All three striker forks are forward of the front wall of the box. The upper pair are integral with their rods, but the lower one, which actuates the second speed gear, is integral with the selector fork. All the selector forks are of an alloy steel suitable for induction hardening and tempering. They are secured by set-screws passed through radial holes in their bosses and screwed into tapped holes in the rods.



Rubber coupling between the half shaft and the stub axle

Spring-loaded ball type locks are employed. They are housed in holes drilled horizontally from the side of the box into the rear wall. The balls register in grooves in the rods. A conventional interlock, comprising two balls and a plunger, is housed in a hole drilled vertically from the top of the front wall of the box. The plunger is carried in a diametral hole in the centre rod, and the two balls are positioned one above and the other below it so that they can register in grooves in one or both of the other two rods, according to which gear is selected.

The striker lever is formed integrally on the end of a short control rod carried in a hole drilled longitudinally in the rear end of the gearbox extension. It is bent approximately at right angles so that its end registers between the lugs of the striker forks. A rubber sealing ring is fitted in a counterbore in the outer end of the hole in which the rod is carried. The control rod on which the striker lever is formed is connected by a flexible coupling to another rod, which is pinned to the gear shift lever. This coupling comprises a rubber disc, on each side of which is bonded a flanged boss. It is secured by two conical ended bolts, screwed one in each boss, to register in a radial hole in the rod. Rotational motion of the rod swings the end of the lever up or down to select the appropriate fork, and striking is effected by axial motion of the control.

Final drive unit

A spiral bevel final drive unit is employed. There are eight teeth on the pinion and forty-three on the crown wheel. This gives a final drive ratio of 5·375 : 1. The differential cage comprises two flanged, cupped components. One houses the differential pinion assembly and carries one of the differential gears, and the other closes the end of the first and carries the other differential gear. The six 10 mm diameter set-bolts that clamp the flanges of the two components together also secure the spigoted-on crown wheel, which is of En 352 and is $6\frac{1}{2}$ in diameter. This two-piece construction has been adopted for the differential cage, because the bosses of the differential gears are exceptionally large in diameter to accommodate the pot-type universal joints at the inner ends of the swinging half-shafts.

The differential pinions and their $\frac{19}{32}$ in diameter spindle are of a material equivalent to En 352. Because of the large diameter of the differential gears, which are of the same material, their teeth are relatively lightly loaded, so the effective length of engagement is only about $\frac{5}{32}$ in. Their overall diameter is 70 mm and their 58·5 mm diameter bosses each bear for a length of 28·5 mm in the differential cage.

Two taper roller bearings, spaced with their centres about $3\frac{1}{4}$ in apart, carry the cage. These bearings are 65 mm inside diameter by 95 mm outside diameter, and their outer races are in flanged, cupped housings spigoted into the side walls of the casing. Each housing is secured by five 7 mm diameter studs. The position and preload on the bearings are controlled by ring-nuts, which are screwed in the outer ends of these housings to bear against the outer races. A lip type oil seal is carried in each ring nut; it bears on the outer periphery of a cup-shaped extension secured by set-screws to the end of the differential gear. Rubber gaiters are clamped round the outer

GEARBOX DATA

	Number of teeth	Diametral pitch	Helix angle	Material	Thickness of gear blank at p.c. diameter
Mainshaft gears:					
4th	29	12·7	30 deg 56 min 26 sec	En 352	$\frac{13}{16}$ in
3rd	24	12·7	29 deg 9 min 22 sec	En 352	$\frac{11}{16}$ in
2nd	18	12·7	30 deg 56 min 26 sec	En 352	$\frac{11}{16}$ in
1st	13	11·288	—	En 352	$\frac{11}{16}$ in
Layshaft gears:					
4th	26	12·7	30 deg 56 min 26 sec	En 352	$\frac{13}{16}$ in
3rd	32	12·7	29 deg 9 min 22 sec	En 352	$\frac{11}{16}$ in
2nd	37	12·7	30 deg 56 min 26 sec	En 352	$\frac{11}{16}$ in
1st	44	11·288	—	En 352	$\frac{11}{16}$ in
Reverse idler	19 and 24	11·288	—	En 352	$\frac{11}{16}$ in

ends of these extensions, and also to the half-shafts, to seal the unit.

An eye is formed at the inner end of the end of each 19 mm diameter half-shaft. A 16 mm pin is carried in the eye, and hardened steel trunnion blocks are fitted on its ends. The external section of these blocks is of a rectangular shape, and their ends, as well as the ends of the pin, are machined to a spherical form. Thus, they can slide in their housings in the differential gears to allow the shaft to move in a plane normal to that in which is contained the axis of the pin, as well as to rotate about that axis.

The overall length of the half-shaft is 17¼ in, and its outer end is splined into the boss of a driving flange of a flexible coupling. This flange is spigoted to the flanged sleeve component of the flexible coupling, to which it is secured by four 7 mm diameter studs. The inner component of the coupling is splined on to the stub axle. A circlip in a groove round the ⅛ in diameter outer end of the half-shaft seats in a counterbore round the outer end of the hole in the boss of the driving flange. This assembly is held in position by a coil spring in compression between the inner end of the stub axle and the outer end of the half-shaft. The spring is located in a ¼ in diameter counterbore in the end of the half-shaft.

The coupling is a 1¾ in long rubber bushed unit. Its inner component is not unlike a spur gear and its outer component has internal teeth. About ¼-$\frac{5}{16}$ in thickness of rubber is bonded between the teeth of the two components. Thus, the drive is taken from the teeth in the outer component, through the rubber in compression, to those of the inner component. Any slight misalignment there might be between the axis of the stub axle and that of the half-shaft places the rubber in shear. Both the inner and outer components are tapered 2 deg at the faces bonded to the rubber. Thus, the rubber is of conical form, although it is of uniform thickness. Its small end is outermost so that the coupling can react the thrust from the compression spring between the adjacent ends of the stub axle and the half-shaft.

The inner component of the coupling is pulled on the 1 in diameter splined inner end of the stub axle by an 18 mm diameter threaded nut and steel washer. This washer, which seats in a counterbore in the end of the inner component, acts as a seal to prevent the escape of lubricant along the splines and out into the space between the driving flange and the rubber coupling.

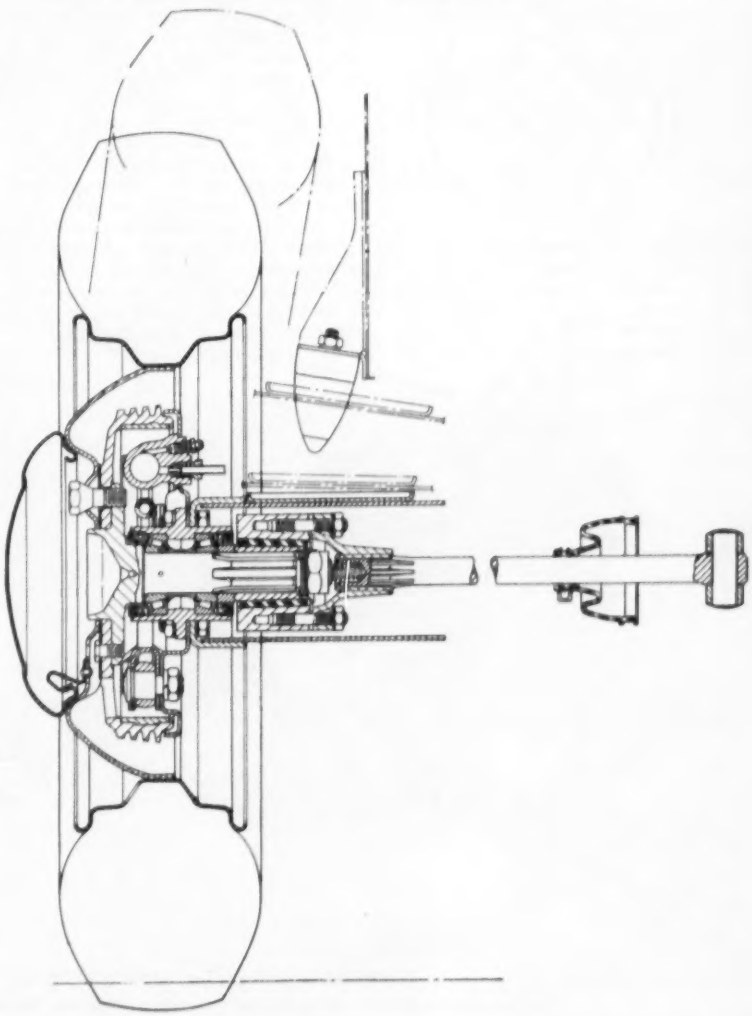
Between the outer end of the inner component and the driving flange for the road wheel, there is an assembly comprising the two taper roller bearings that carry the wheel hub, spaced with their centres about 1¼ apart, and two distance pieces, one between the inner races of the bearings and another between the inner race of the inboard bearing and the coupling. A collar formed integrally in the bore of the malleable cast iron hub separates the outer races of the two bearings. Two lip type oil seals are fitted, one in each end of the hub. The inner one bears on the distance ring between the flexible coupling and the adjacent bearing, and the outer one bears on the stub axle immediately outboard of a shoulder between the driving flange and the inner race of the outer bearing.

An aluminium alloy brake drum, with a cast iron insert fitted in the rim by the Fiat A-Z process, is spigoted on to the driving flange formed at the outer end of the stub axle. This drum is secured to the flange by two 8 mm diameter set-bolts with special thin heads, and the wheel disc is pressed in such a shape as to clear these heads. Both bolts are a close fit in the hole in the brake drum and are screwed into tapped holes in the flange. One of them incorporates a peg extending outwards from the head, to register in a hole in the wheel disc. This ensures that the wheel is always assembled in the same position relative to the brake drum and driving flange.

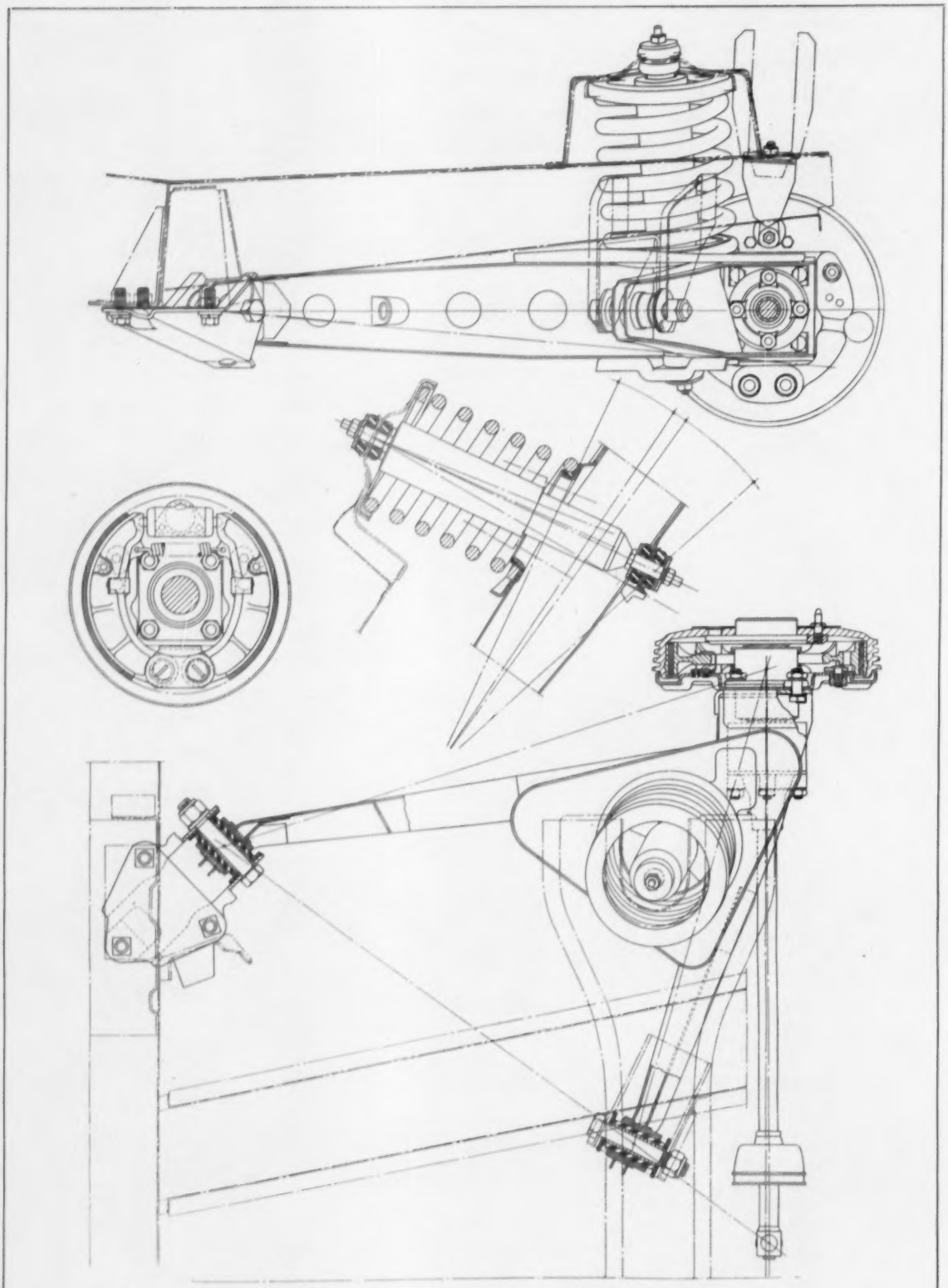
The wheel disc is secured by four 12 mm diameter set-bolts with conical seating faces under their heads. Instead of the wheel disc being dimpled to form the seats for the bolt heads, as is the more usual arrangement, the heads seat in a conical hole in the disc, which is dimpled out to meet them. This provides a firm backing against which the bolts are tightened. A thin, steel face-plate is interposed between the steel wheel disc and the aluminium brake drum to prevent chafing of the softer metal. All six set-bolts securing the wheel and brake drum are screwed into tapped holes on a pitch circle diameter of 3⅞ in in the flange. The brake back plate is interposed between a flange round the hub and the triangulated link of the suspension system, and the whole assembly is held together by four 10 mm diameter set-bolts.

Rear suspension

At the rear, the suspension system on each side comprises a triangulated link, used in conjunction with a coil spring, co-axial with which is a tele-



Aluminium alloy brake drums with cast iron inserts are employed at the rear



ARRANGEMENT OF THE REAR SUSPENSION

The layout is simple and well suited for application to the rear engine arrangement

scopic shock absorber. Lateral and drag loads on the wheel hub are taken by the triangulated link, and the half-shafts take only torsional loads. The geometry of the system, with reference to a tranverse vertical plane through the centres of the two rear wheels, is as follows. The centres of the universal joints and the pivots of the triangulated links are all in the same plane. On each side a line through the centres of the wheel and of the pivot bearing on the inward extending link makes an angle of 16 deg to the transverse vertical reference plane. This places the centre of the pivot bearing 125 mm in front of this plane and the same distance outboard of the longitudinal axis of the chassis. The forward extending link makes an angle of 72½ deg with the reference plane, and the centre of its pivot is 513 mm in front of this plane and 408½ mm from the longitudinal axis of the vehicle.

Thus, the whole of the triangulated link is in front of the half-shaft, which is inclined to the rear at an angle of 19 min to the reference plane. This places the centre of the universal joint 3 mm behind the transverse reference plane and only 32 mm outboard of the longitudinal axis of the chassis. With the vehicle in the static laden condition, this centre is 247 mm above the ground, and the half-shaft is inclined upwards at an angle of 1½ deg; at full bump the centre is 182 mm above the ground and the shaft is at an angle of 8½ deg from the horizontal.

The spring rate is 262 lb per in. This gives a rate at the wheel of 84·84 lb per in. The unsprung weight is approximately 72·7 lb. To the laden position, the deflection of the spring is 3 $\frac{9}{16}$ in, and to the full bump position it is 5 $\frac{1}{16}$ in. The corresponding deflections of the wheel are respectively 6 $\frac{7}{16}$ in and 8 $\frac{33}{64}$ in. In the laden condition, the height of the roll centre is 262 mm above the ground.

The construction of the triangulated links is as follows. Their transverse and forwarding extending arms are joined together by 2 mm thick gusset plates at the apex of the link, which is adjacent to the wheel. One plate is welded on top of each pair of arms, and the other below. The upper plate forms a seating for the spring and in it is punched a hole, through which the telescopic shock absorber is passed. The lower end of the shock absorber is attached to the bottom gusset plate and its upper end is secured to the centre of the upper spring pan. Both ends are fitted with circular rubber sandwich type units.

A channel section, of 2 mm thick sheet steel, forms the transverse arm of the link. The section is on its side, with its flanges extending to the rear. At its outer end is a 4 mm thick plate of rectangular shape. This plate is flanged on three edges; two are welded to the flanges of the channel section of the arm and the third to the base of this section. Adjacent to the inner end of the transverse arm, the channel is closed by shallower channel section inserted between its flanges. This closing plate is 1½ mm thick and extends from the inner end to a position just inside the section reinforced by the gusset plates that carry the spring and the shock absorber end fitting.

The tubular housing for the rubber bush of the pivot is passed through flanged holes in both the closing plate and the main channel section, and is welded in. A rubber-to-metal bonded bush with steel inner and outer sleeves is employed. The inner sleeve of the bush is 2½ in long and the outer sleeve is 1⅞ in long.

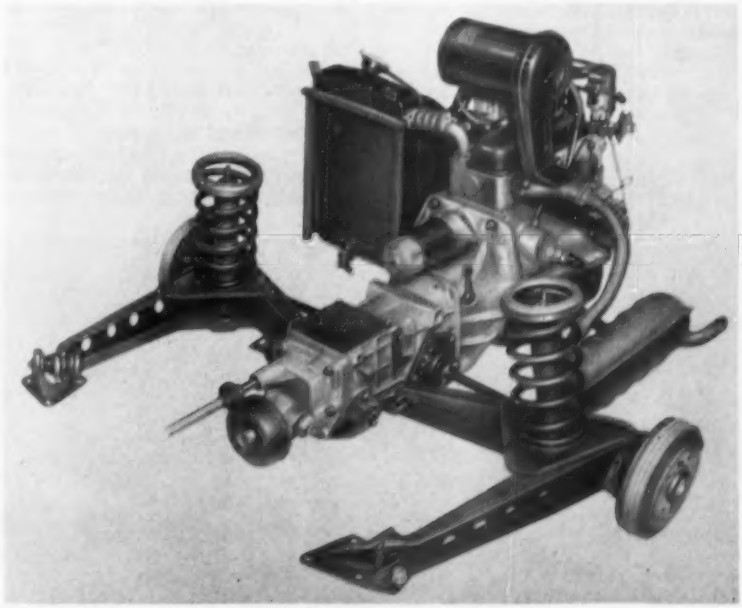
A 14 mm diameter pivot pin is passed through holes in the lugs of a three-piece bracket on the arm of the Y-shaped extension of the box section, central longitudinal member of the vehicle structure. This bracket comprises a 3 mm thick channel section spot-welded to the undersurface of the arm of the Y-shaped extension, and two 2 mm thick side plates spot-welded to the flanges of the channel section, where the pivot pin is passed through it, and to the vertical face of the structural member. A self-locking nut on the end of the pin is tightened to clamp the inner sleeve of the bush between the lugs, and adjustment washers are interposed between the ends of the sleeve and the lugs.

The assembly at the pivot end of the forward extending arm is similar, but the reinforcing plate welded inside the channel section of the arm is only a short one and is incorporated simply to afford additional support for the pivot bearing housing. At the outboard end of this arm the flanges of the channel section enclose, and are spot-welded to, those of the lateral arm. In addition, a flange is turned outwards from the end of the vertical face, that is, the base, of the channel section arm and spot-welded to the vertical face of the lateral arm.

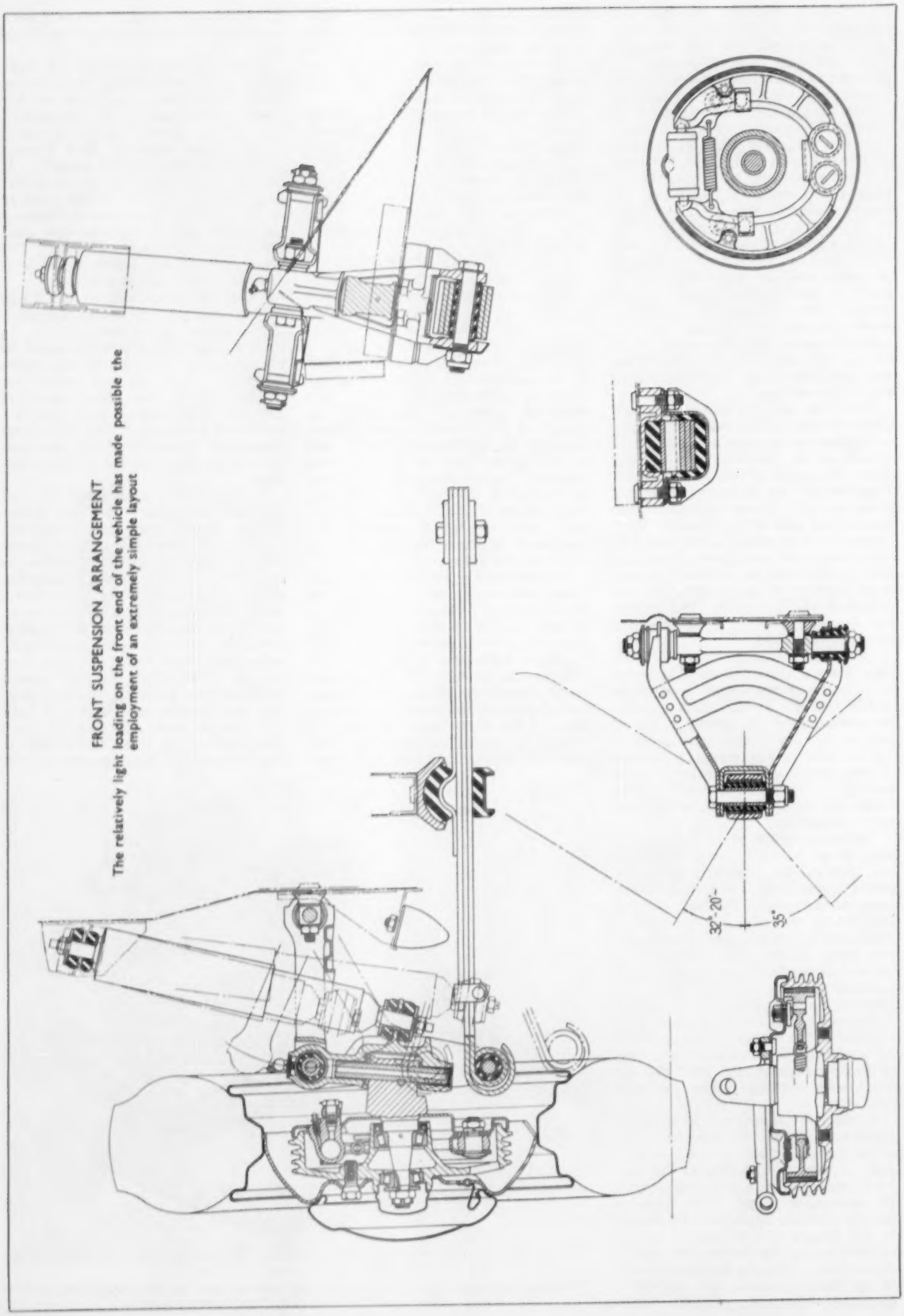
Both ends of the spring are fitted with cupped rubber rings about 4½ mm thick. The lower ring seats on the upper gusset plate of the triangulated link and is located by an upwardly turned flange round the hole through which the shock absorber projects. At the upper end of the spring, the rubber ring seats in a shallow dished pressing in the pan welded between the arms of the forked end of the transverse cross member behind the rear seat. The upper end of the shock absorber is secured to this dished pressing.

There are seven coils in the En 45 spring, which is 5 in overall diameter. The diameter of the wire is $\frac{11}{32}$ in. In the fully laden condition the length of the spring is 6 $\frac{1}{16}$ in and its free length is 9$\frac{1}{2}$ in. The rebound stops are incorporated in the shock absorbers and the bump stop on each side is a rubber on a bracket welded to the rear wheel arch. In the full bump position, this rubber bears on the upper gusset plate.

It is of interest to compare the Fiat 600 rear suspension and the transmission system with those employed currently in the more conventional vehicles, that is, with the engine at the front. So far as the suspension alone is concerned, the semi-elliptic spring arrangement generally employed in other vehicles comprises two brackets, a shackle, three pivot pins and bushes, and a heavy leaf spring on each side. On the other hand, the Fiat system comprises two brackets, only two pivot pins and bushes, no shackle, a light coil spring and the pressed steel triangulated arm. Even without taking into account the improvement in ride



In the rear suspension, practically all the drag loads are taken by the trailing arms, and the lateral loads are reacted by the transverse arms



FRONT SUSPENSION ARRANGEMENT

The relatively light loading on the front end of the vehicle has made possible the employment of an extremely simple layout

obtained by the employment of independent rear suspension and reasonably accurate control of the damping, the Fiat system would appear undoubtedly to be the more attractive.

However, it is also necessary to consider the relative costs of the transmission systems. By the employment of the rear engine layout, the following economies have been effected. The propeller shaft, a sliding joint and two universal joints have been eliminated. Moreover, it has been possible to place the floor at a lower level than would otherwise be possible, and there is also less obstruction in the centre of the floor. Further economies arise because the gearbox and final drive are in one casing. In addition the axle tube on each side is eliminated and, because the half-shafts have to take only torsional loads, they are of lighter construction than would otherwise be practicable. Nor must it be forgotten that the reduction in overall length of the vehicle, made possible by the employment of the rear engine layout, also represents an appreciable economy.

The increases in cost that tend to offset these advantages are as follows. Two pot-type universal joints are housed in the differential gears, and the differential cage is in two pieces instead of one. Three oil seals are employed on each side instead of the two, or possibly only one, that would otherwise be needed, and two rubber gaiter assemblies are required to seal the universal joints. The cost of the rubber coupling assembly between the outer ends of the half-shafts and the stub axles must also be taken into consideration, but there are not any sleeve type sliding joints.

This comparison is only of a general nature because even conventional transmission systems vary in detail. For example, wheel hub assemblies vary considerably as between one model and another. Nevertheless, it does appear that there cannot be a great deal of difference between the total cost of the Fiat arrangement and that of the more conventional systems. It must also be remembered that although the improvement obtained by employing independent rear suspension is not so marked as that given by independent front suspension, the gain is nevertheless real.

Some rear engined vehicles manufactured in the past have been notorious for sudden break-away when cornering. The Fiat designers state that they have overcome this difficulty by suitable arrangement of the suspension. In the static laden condition, the centres of the universal joints on each side of the final drive unit are 9·73 in above ground and 1¼ in on each side of the longitudinal centre line of the vehicle, and the axis of each half-shaft is inclined upwards 1½ deg from the horizontal. The camber angle change from static laden to full bump positions is from −1½ deg to −9½ deg. Thus, when the vehicle is cornering, the camber on the outer wheel, which is the more heavily loaded of the two, increases in such a way as to afford increasing reaction to the lateral thrust.

An interesting feature of this vehicle is that the ratio of the load on the front wheels to that on the rear wheels is almost exactly the same in the fully laden as in the unladen conditions. This is because the passengers and luggage are disposed symmetrically about the centre of gravity position of the unladen vehicle. The laden weight on the front wheels is 805 lb, and on the rear wheels it is 1170 lb. Undoubtedly the relatively light loading of the front wheels has made practicable the employment of such a simple front suspension system.

Front suspension

The front suspension system is a double transverse link arrangement, in which the lower link on each side is formed by the end of a transverse leaf spring, and the upper link is a simple pressed steel wishbone. The principal dimensions of the system are as follows: swivel pin angle 5 deg 30 min; caster angle 9 deg; toe-in measured between the rims, in the laden condition, 0·236-0·315 in; camber angle −1 deg, fully laden, and ±2 deg 30 min at the full bump position. From the fully laden to the full bump position the track change is ⅝ in.

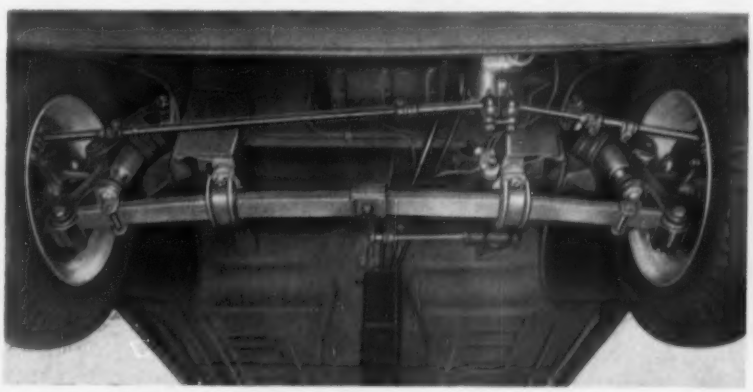
An ingenious feature of the system is the way in which an anti-roll effect has been obtained without the employment of an anti-roll bar. The leaf spring is supported by two rubber pads, 500 mm apart and equally disposed about the longitudinal axis of the vehicle. Thus, when one end of the spring deflects upwards it causes the centre of the spring to bow downwards, and therefore the other end of the spring also to deflect upwards. The spring rate when both wheels are deflected upwards simultaneously is 93·5 lb/in and, when one wheel only is deflected the rate is 156·8 lb/in. To the laden position, the deflection is 3⅛ in and to full bump it is 6⅛ in. The unsprung weight of the system is 68·3 lb.

Another interesting feature of this suspension is that as the wheel rises to full bump, the effective length of the cantilever end of the spring is reduced because the rubber stop bears on the leaf spring at a point slightly less than 5½ in outboard of the rubber support—the spring eye is about 10⅛ in from this support. In this way the spring rate is increased, not only by the addition of the effect of the rubber of the bump stop, but also because of the reduction in the effective length of the spring.

The spring is of En 45. Its length between eye centres is 40⅛ in. There are four leaves, each 1¾ in wide; the upper leaf is 4 mm thick and the others are 5 mm thick. They are bolted together at the centre, between two plates about 2⅜ in long. At a distance of 250 mm on each side of the centre, the top leaf of the spring is bent to form an arch, the inside radius of which is about ½ in. The ends of the top leaf are about 60 mm outboard of the centre of the arch section.

This arched portion at each end of the spring seats in a rubber lining bonded in a dished housing bolted-up to the inverted top-hat section longitudinal member of the vehicle structure. It is retained by a channel section pressed steel cap in which is bonded another rubber lining. This cap is bolted-up beneath the spring to clamp it in the housing. The traverse section of the interior of the housing is of semi-circular form, while its longitudinal section is of rectangular shape to prevent the rubber from bulging out at the front and rear ends. On each side the loads applied by the spring to the rubber tend to force it into the housing rather than to squeeze it out. The rubber in the cap is radiused on each side so as to avoid stress concentrations where the spring enters it. Its front and rear edges are turned up in front of and behind the spring so that there is no metal-to-metal contact between the spring and the cap. The rubber is undercut in the area adjacent to the lower corners of the spring, as viewed in cross-section. This is to prevent chafing and stress concentrations in the rubber.

Estendbloc RIV bushes are fitted in the spring eyes. These bushes are of rubber, bonded between inner and outer metal sleeves. In the event of



A progressive rate has been obtained by careful design of the bump stop layout relative to the spring mounting brackets

breakage of the first leaf, the suspension unit cannot come completely adrift, because the ends of the second leaf of the spring are wrapped round the spring eyes. The pivot pins are 0·551 in diameter, and the outside diameter of the bushes is 1 $\frac{1}{16}$ in.

Two 3$\frac{1}{2}$ mm thick channel section pressings form the arms of each upper wishbone link. A hole is punched in the inner end of each and is flanged to carry the pressed-in outer sleeve of the rubber bush of the pivot. This sleeve is shouldered as well as flanged, so that it can transmit axial thrust to the rubber, which is bonded into it. The outside diameter of the larger portion of the housing is 1 $\frac{7}{32}$ in, while the outside diameter of the smaller portion is 1 $\frac{3}{4}$ in. The inner sleeve of the rubber bush is of parallel section. It is $\frac{7}{32}$ in diameter by 1 $\frac{5}{16}$ in long.

The two bearings are carried on the ends of a pivot pin forging secured to the vehicle structure by two 10 mm diameter bolts. Shims are fitted between the forging and distance pieces that are interposed between it and the vehicle structure. These are to adjust the camber angle. The bearing assemblies are retained by split-pinned castellated nuts on the ends of the pivot pins. These nuts are pulled up against dished washers in which the ends of the rubber bushes are compressed to form flanges to transmit axial loads.

Between the outer ends of the wishbone arms is spot-welded a channel-section, in which is carried a rubber bush bonded to an inner and outer sleeve. A 2$\frac{1}{2}$ mm thick channel section tie-plate is spot-welded to the lower flanges of the two arms of the wishbone. This tie connects the two arms, thus completing the triangulation of the wishbone and stiffening it. It is bowed inwards to clear the shock absorber which passes between the arms of the link. The distance between the centres of the pivot pin bushes is about 6$\frac{3}{4}$ in, and the centre-to-centre length of the link is about 5·72 in.

A knuckle forging with an eye at its upper end and a fork at its lower end, to carry the pins and rubber bearings at the outer ends of the transverse links, houses the swivel pin bearings. The circular rubber-sandwich type fitting at the lower end of the telescopic shock absorber is carried in another eye formed in the knuckle forging at a point inboard of the centre of the swivel pin. At the top of the shock absorber, a similar type of end fitting is attached to a bracket spot-welded to the inner face of the wheel arch.

The $\frac{3}{4}$ in diameter swivel pin is of a material equivalent to En 352. It is carried in a boss at the inner end of the stub axle forging, and is located by a cotter-pin assembled into a hole in the boss to register in a groove on its periphery. The centre of the swivel pin is 59·9 mm inboard of the centre of the wheel, and its angle of inclination is such that the point of intersection of its axis projected and the ground is 29·5 mm inboard of the centre of contact between the wheel and the ground.

Both of the hard bronze swivel pin bearing bushes are 1 $\frac{3}{16}$ in long. They are spaced with their centres 3 $\frac{7}{32}$ in apart. Their housing is bored from between the arms of the fork at the lower end of the forging, through both knuckles, and diametrically through the eye at the top end of the forging. Both ends are sealed by peened-in steel discs. A grease nipple is screwed into the upper disc. The lubricant passes round an annular groove in the periphery of the outer sleeve of the rubber bush in the eye which carries the outer end of the wishbone link, and thence into an axial hole in the swivel pin. It is then passed through radial holes to the swivel pin bearings.

A thrust bearing of the two-washer type is fitted between the housing for the upper bearing and the boss on the stub axle, in which the swivel pin is carried. Both washers are of a case-hardened carbon steel and are free to rotate. A rubber ring, with a steel band round it, is fitted round this thrust bearing to prevent the entry of abrasive matter. Another washer is interposed between the lower face of the boss at the inner end of the stub axle and the lower knuckle bearing housing. This washer is of a copper-tin alloy or alternatively En 32A.

Two taper roller bearings carry the wheel on the stub axle. The outer bearing is 15 mm inside diameter by 42 mm outside diameter, and the inner bearing is 23 mm inside diameter by 52 mm outside diameter. They are spaced with their centres approximately 1$\frac{1}{2}$ in apart. The bearings are assembled from each end into their housings in the malleable cast iron hub, which is integral with the brake drum. The whole assembly is retained by a split-pinned castellated nut and plain washer on the 14 mm diameter threaded end of the stub axle. A lip type oil seal, housed in the inner end of the hub, bears on the stub axle. The outer end of the hub is closed by a pressed-in steel cap. Conical seating bolts, similar to those employed at the rear secure the wheel disc to the integral brake drum and hub casting.

Steering

A two-piece track rod, steering layout has been adopted, and a Fiat worm and helical sector steering gear is employed. This gear gives a ratio of 2 : 26 and the 15$\frac{3}{4}$ in diameter steering wheel is rotated 2$\frac{1}{4}$ turns from lock to lock. On full lock the wheel angles are 35 deg on the inner wheel and 32 deg 20 min on the outer wheel. This gives a turning circle of 28 ft 6$\frac{1}{2}$ in diameter.

The drop arm is of En 19A and its effective length is 3 $\frac{13}{16}$ in. It is connected by self-adjusting ball joints to the $\frac{13}{16}$ in diameter track rods. The length of the right-hand rod is 29$\frac{11}{16}$ in between the centres of its ball joints and that of the left-hand rod is 13 in. Each rod is in three pieces comprising a central sleeve with internally threaded split ends into which the two outer portions are screwed. Adjustment can be effected by rotating the sleeve, since the thread at one end is right-handed and that at the other end is left-handed. It is locked by tightening clamps round the split ends. The steering arm on each wheel is integral with the stub forging. This arm also reacts brake torque, since the brake back plate is secured by only two 8 mm diameter bolts, one through a hole near the outer end of the steering arm and the other through a lug on the opposite side of the stub axle flange.

Brakes

Hydraulic brakes of the two leading-shoe layout are employed at the front and rear. All the drums are 7 $\frac{3}{32}$ in diameter and the shoe width is 1 $\frac{1}{16}$ in. The shoe area is 33·40 in² at the front and the same at the rear. Although a cast iron drum is employed at the front, that at the rear is of aluminium alloy with a cast iron liner bonded to it by the A-Z process patented by Fiat. No doubt this arrangement is adopted because the body panelling screens the rear brakes from the air flow to a greater extent than those at the front. From the accompanying illustrations it can be seen that both at the front and rear the brakes are also almost completely enshrouded by the wheel discs.

The brake and clutch pedals are mounted on a common pivot pin carried by two brackets, one bolted to the lower face of the toe-board and the other to the left-hand longitudinal member that carries the front suspension. The pivot bearings are sintered hard bronze bushes. They are $\frac{3}{8}$ in inside diameter by 1 $\frac{3}{16}$ in long. The lever ratio of the brake pedal is 4·87 : 1, and the travel is 5$\frac{1}{4}$ in. As has already been stated, the hand brake is of the expanding shoe type and is on the front end of the gearbox layshaft. It is mechanically operated and its lever ratio is 9·3 : 1. By applying the hand brake to the layshaft, a considerable length of control run has been eliminated and brake compensation difficulties do not arise.

Electrical equipment

A Marelli type 6VB 7/A 12-volt battery or a Tudor type 6TO 3F battery is employed. Both have a capacity of 28 amp-hr. A Fiat B76-0·5/12 S starter with an eight-tooth pinion is fitted. It is engaged by a lever mounted on the propeller shaft tunnel. The dynamo is a Fiat type R90-180/12-2500 unit; its continuous output rating is 180 watts. A Fiat A/4-180/12, three-unit voltage regulator is employed. The three units are: the cut-out relay, voltage regulator and current regulator. The coil is a Marelli type B17/A unit and it is used in conjunction with a Marelli S70 B contact breaker and distributor. The sparking plugs are of the same manufacture and are the M14-12/225 type. Carello headlamps are fitted. They have 12 volt-45/40 watt bulbs of Siem manufacture. The side lights incorporate the direction indicators and have 12 volt-3/20 watt bulbs.

WELDALLOY TRUCK BODIES

All-welded Light Alloy Structures of Minimum Weight

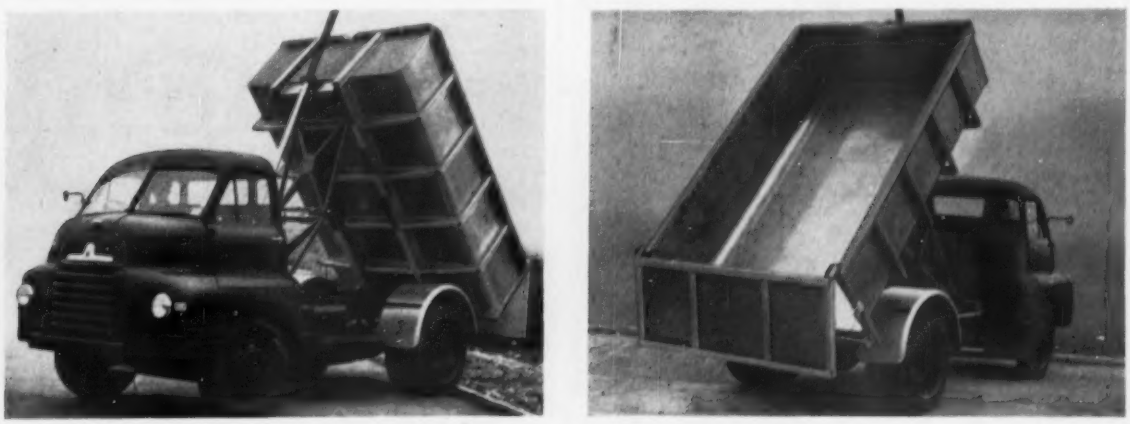
FOR the economic transport of bulk loads of such relatively low-value products as sand, gravel, ballast, coke, limestone or asphalt, a vehicle of the lowest practical tare weight is demanded. While bodies of wood and steel, or of welded steel, are still commonly used, there has been an increasing adoption of light alloy bodies in recent years. These not only materially reduce weight but are much more resistant to corrosion and erosion which tend rapidly to dilapidate steel bodies. When handling wet ballast or exceptionally sharp sand, it is not uncommon for two steel bodies to be required during the life of a single chassis. It is usual for light alloy bodies to outlast the working life of the original chassis and to be re-used. Numerous instances are reported of bodies in service on a third chassis. When ultimately discarded they are still of considerable value as scrap metal.

A 7 yd³ body on a Big Bedford diesel-engined chassis

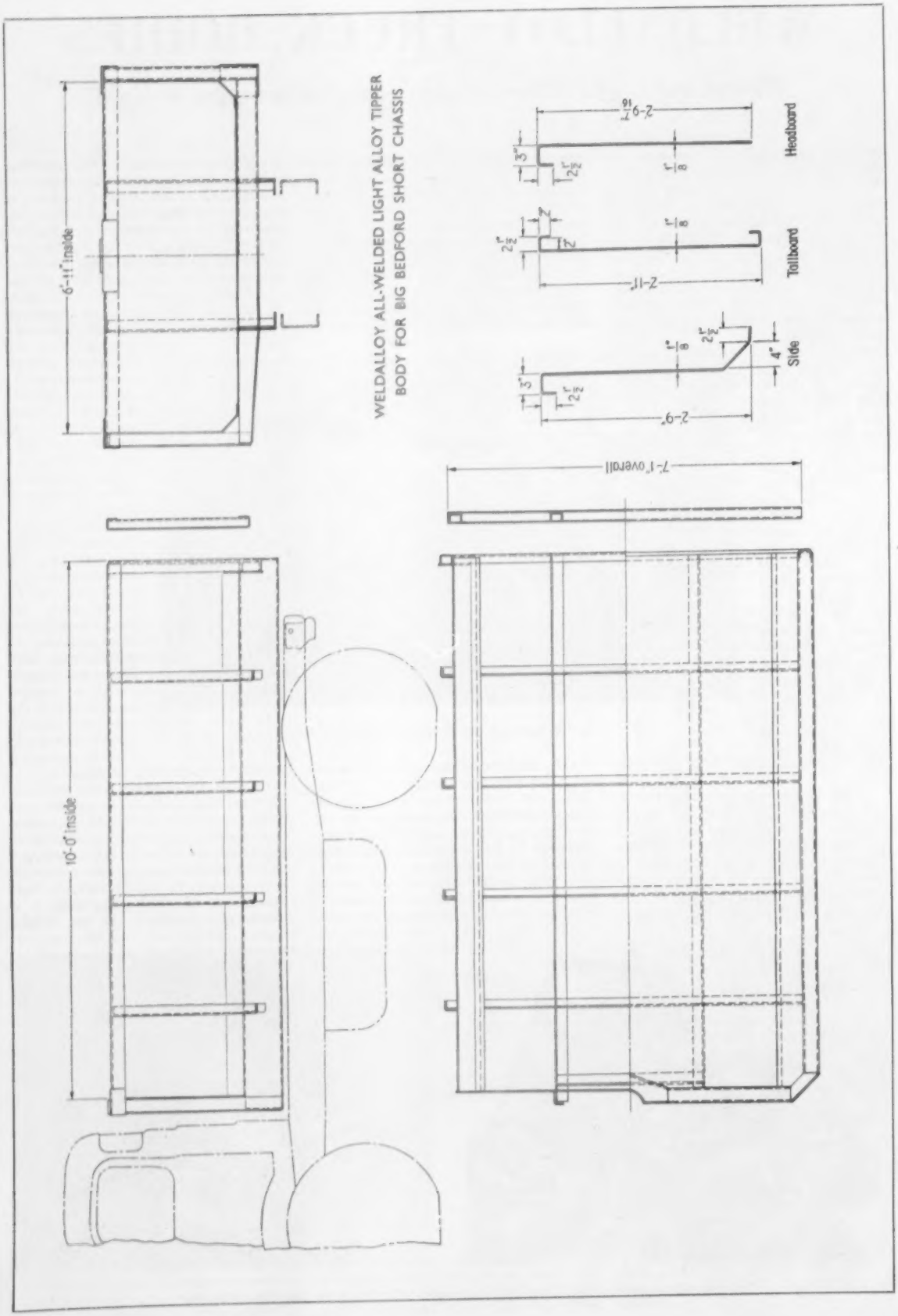
These bodies are generally framed and panelled constructions, making extensive use of extruded sections, and are assembled by bolting or riveting. They can effect a weight-saving of about 50 per cent as compared to a conventional welded steel body, but this does not represent the maximum possible reduction since metal is duplicated at the flanges necessitated by the method of construction. Welding, which could enable the most advantageous use to be made of the lighter metal, has not hitherto been widely employed. Arc-welding by orthodox methods requires the use of a flux which has a corrosive effect on the base metal. All trace of the flux must be scrupulously cleared away from the welds, and the difficulty in production of ensuring this throughout a large structure creates an unpredictable hazard and virtually precludes its use.

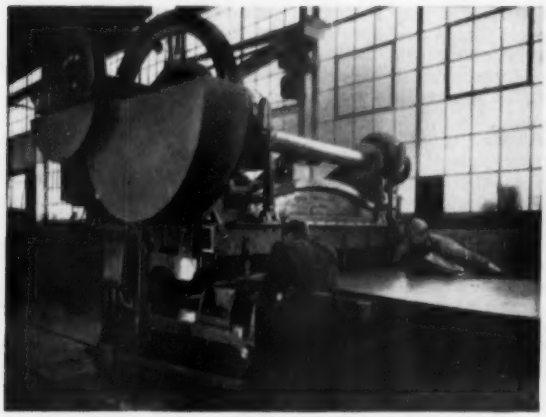
These considerations led to the conception of an all-welded light alloy body in which advantage was taken of the commercial availability of marine-purpose plates and sheets, and of fluxless welding by means of an argon-shielded arc process. In collaboration with the Development Department of the British Aluminium Co. Ltd., a design was prepared for a 7 yd³ tipping body for the Big Bedford, type S, short chassis, 7-tonner. The prototypes showed a reduction in weight of 60 to 65 per cent in comparison with similar capacity steel bodies, and from 20 to 25 per cent with equivalent riveted or bolted light alloy bodies. After rigorous testing in the hands of private operators, the design was standardized in three capacities, 6, 6½ and 7 yd³, differing only in the height of the side plates. The manufacturers, Weldalloy Bodies Ltd., Syntilla Works, Luton Road, Dunstable, are equipped with heavy plant for the shearing and manipulation of plates, and have extensive experience, in regular production, of the Quasi-Arc Sigma consumable-electrode, argon shielded, arc-welding process.

The body is designed, somewhat on the lines of a conventional welded steel body, essentially as a load container. Structurally, it is relatively flexible in order that shock loads are distributed and that any chassis movement in operation can be accommodated. Built throughout of plate and sheet, it is fabricated completely in the works.



The body tipped to show at left the underframe and at right the clear one-piece floor


WELDALLOY ALL-WELDED LIGHT ALLOY TIPPER
BODY FOR BIG BEDFORD SHORT CHASSIS
6'-11" inside
10'-0" inside
7'-1" overall
Headboard
Tailboard
Side
2'-9 7/16"
2'-11"
2'-9"
3"
2 1/2"
1"
8
4"



An 8 ft wide, 24 in gap, Bennie guillotine is used for cutting plates to size

Body components are flanged or folded on a 13 ft Verson press brake

Angle section stiffeners and flanged sides and head board enable the most economical disposition of material to be made. As with steel sheet, there is complete freedom to design to best advantage. Main inside dimensions are length 10 ft and width 6 ft 11 in. The height of the sides is varied to give the required capacity, being 29 in, 31 in and 33 in for 6, 6½ and 7 yd³ respectively.

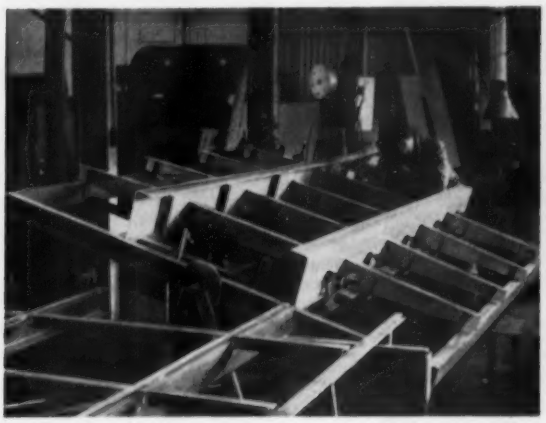
Plates are cut to size on an 8 ft Bennie guillotine with 24 in gap frames and the flanging or folding of large members is carried out on a 13 ft Verson press brake. The floor is a single sheet of NS6-½ hard alloy $\frac{3}{16}$ in thick and 6 ft wide—the maximum width available. This material contains 4½ to 5 per cent magnesium and, not being heat-treatable, is work-hardened by cold rolling. For the underframe, the two longitudinals are folded to angle section, 9 in × 3½ in, from ½ in plate of NP5-M alloy containing 3½ to 4 per cent magnesium. This is of flanging quality and is in the fully annealed state. The central cross members, 5 in × 2 in angle, and the outrigger cross members, tapering from 5 in to 3 in × 2 in angle, are in similar material $\frac{3}{16}$ in thick. These components are set up on a pivoted jig and welded up ready for building on to the floor plate. At the front, an 8¼ in × 3 in × ¼ in angle, to receive the tipping gear connection, joins the ends of the two longitudinals, while at the rear the underframe is closed by a 5 in × 2 in × $\frac{3}{16}$ in channel extending across the full width of the body.

Body sides are single sheets in NS6-¼ hard alloy, ⅛ in thick. They are folded outwardly at the top run, 3 in wide and 2½ in deep, while the lower run is folded inward at an angle of 45 deg and then flanged to make a 1 in lap joint with the floor plate. Four 3 in × 2 $\frac{3}{16}$ in × $\frac{3}{16}$ in angle stiffeners and a 3 in × 2 in × $\frac{3}{16}$ in channel rear pillar of the same material are jigged and welded to form a side sub-assembly. Only intermittent welding is employed to attach the stiffeners to the plane surface of the side sheet. The upper ends of the stiffeners are entered and welded into the top fold of the sheet, while at their lower ends their webs are arranged to lap the webs of the underframe outriggers and are welded up in the final assembly.

Both headboard and tailboard are also of ⅛ in thick NS6-¼ hard alloy. The headboard is a single sheet, dimensioned to overlap the sides and floor plate by ⅛ in for fillet welding. At its upper edge it is folded in similar manner to the side sheets, but at the centre the fold is cut away to provide clearance for the tipping gear cylinder when the body is normally seated on the chassis frame. As shown in the illustrations, a fabricated reinforcement of an irregular channel section is built in to compensate for the loss of section. In passing, it may be noted that at the forward corners of the body the upper folds of both the sides and the headboard are mitred. In the final assembly these junctions are braced by welded-in angle pieces.

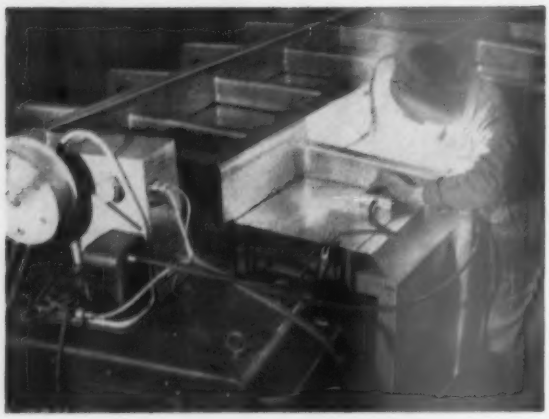
A single sheet, 2 in deeper than the sides and folded at both upper and lower edges 2½ in wide and 2 in deep, forms the tailboard. The ends are closed by channels and intermediately two channel stiffeners are welded in. All these sections are ⅛ in thick. This component is also built up on a welding jig.

The main structure is welded up in an inverted position on a large platform jig. Over each side of the jig a



Underframe components on jig for welding by the Sigma argon-shielded arc process

Welding jig for one-piece side and stiffener members



Welding the underframe and the sides to the floor plate

fabricated body side depends by its base flange. The floor plate overlies these flanges, making a 1 in lap, and on the floor plate is positioned the underframe. At the front end, the headboard is mounted in place. The underframe is welded continuously and completely (both sides of the web of each component) to the floor plate, and the floor plate is continuously welded to the side sheet flanges. At the junctions of the floor tail-end channel and the rear corner posts, flat plates welded to the two members and to the side sheets, buttress the joints and furnish support for the angled lower ends of the side sheets. After welding in the headboard, the assembly is stripped from the jig, turned over, and placed on the shop floor. The sides are clamped by means of a pair of channel girders to ensure correct positioning, and the internal seams, the lap of the sides to the floor plate, and the floor and side junctions of the headboard, are continuously welded. Minor operations to complete the body include welding in the front corner and the headboard fold reinforcements already mentioned and the final welding of the lower ends of the side stiffeners to the extremities of the underframe outriggers. The tailboard is top hung and bottom latched by means of conventional fittings.

The Sigma welding equipment is completely portable; the cabinet housing the metal rectifier being mounted on wheels and moved to the work as required. Normally, the electronic control unit and the wire-drive unit are arranged in a common assembly which is placed either on the cabinet or in some adjacent location. When working in restricted space, however, the wire-drive unit can be detached from the control and brought nearer to the work. A relatively light watercooled welding gun is used and connections are neatly arranged to provide maximum flexibility in manipulation. The welding wire passes through a separate flexible conduit, but the argon supply pipe, the water supply pipe and the water discharge pipe are grouped together in a single rubber tubular sheath. Of reduced section to minimize weight and enhance flexibility, the current cable passes through the water discharge pipe and is thus continuously cooled during operation.

A remote control box, connected by a single cable to the control unit, is brought within reach of the operator so that adjustment of arc length or rate of wire feed can be made without leaving the work. This box also incorporates an inching control by means of which the wire is fed beyond the argon nozzle before the arc is struck. Wire feed can be pre-set at any rate from 18 in/min to 224 in/min and the electronic control maintains the rate accurately, independent of variation in load. Solenoid valves govern the flow of argon and of cooling water while welding. The wire feed is shut off automatically when the arc is broken.

Beyond removing oil, grease or heavy dirt, the work requires no preparation and, as already stated, no flux is needed. The argon shield confines the spatter and there is no residual slag. When completed, the weld is exceptionally neat and clean, and no dressing whatsoever is necessary. The body is supplied and operated in the unpainted condition.

Total weight of the 7 yd³ body is 5¼ cwt. By way of comparison, a typical 6yd³ welded steel body weighs 13¼ cwt and a 7 yd³ light alloy body, assembled as distinct from welded, weighs 7¼ cwt. Its use not only permits an increased payload to be carried without the scheduled maximum gross vehicle weight being exceeded, but it lowers the unladen weight of the vehicle sufficiently to bring it into the "under 3 ton, 30 m.p.h." class. As an example, the Big Bedford short chassis, powered by the Perkins R6 diesel engine, weighs only 2 ton 19¾ cwt when fitted with the Weldalloy 7 yd³ body and a tipping gear. The breakdown of the weight is as follows: chassis 2 ton 12 cwt, body 5¼ cwt, tipping gear 2¼ cwt, light alloy rear mudguards and steel brackets ¼ cwt. The gross laden weight of the vehicle is 10 ton 4 cwt. Maintenance and repair of the body will be virtually negligible as compared with a steel or wood body, and the possibility of working longer daily mileages by running at 30 m.p.h. instead of 20 m.p.h., makes such a combination of chassis and body economically attractive. Weldalloy bodies are produced for Lorry Bodies (Luton and Dunstable) Ltd., Dunstable, Bedfordshire, and distributed through the dealer organizations.

Final welding of internal longitudinal lapped seams of sides to floor plate

MOUNTING DIAMONDS

CONVENTIONALLY, up to 90 per cent of a diamond is buried in order to obtain rigidity and to avoid loss. A report in the Journal of the Franklin Institute states that Dr. H. Tracy Hall, of The General Electric Co., U.S.A., has developed a novel method of mounting diamonds. Using a titanium hydride wetting agent and a silver-copper solder, a small stone is induction brazed into a shallow tool cavity, in an argon or hydrogen atmosphere. It is claimed that smaller and therefore cheaper stones can be used; the anchorage is more secure; the normally wasted "root" is eliminated; heat transfer is better and consequently working life is extended.

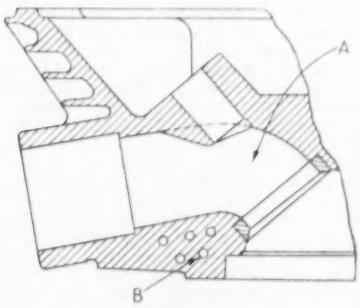
CURRENT PATENTS

A Review of Recent Automobile Specifications

Rapid warming-up

IN order to reduce to a minimum the period during which an engine is compelled to run at an unfavourable working temperature after starting, an automatically controlled heat-exchange apparatus is included in the lubrication system. When the engine is cold the lubricating oil is first passed through a hot zone of the engine, such as the cylinder head or cylinder wall, and there heated directly without the application of an external source of energy. As soon as the engine is warmed-up a thermostatic control short-circuits the heating conduit and the lubrication system operates normally. The invention is particularly suited to air-cooled engines but can also be used with advantage on water-cooled engines and supercharged engines.

The example illustrated refers to an air-cooled cylinder head. The heat interchange is located in the metal mass below the exhaust port A. Here is provided a plurality of ducts B through which the cold oil is forced when the engine is started-up or when it has an unduly low



No. 721027

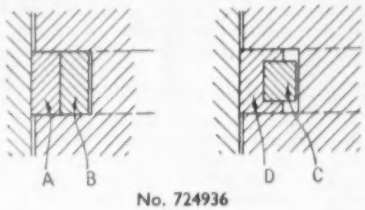
temperature. These ducts are short-circuited by a conventional thermostatic valve when the oil reaches its prescribed working temperature. *Patent No.* 721027. *Bayerische Motoren Werke A.G.* (*Germany*).

Bi-metallic oil-control ring

THIS invention relates particularly to oil-control rings which, in conventional forms, cannot be stressed to meet requirements throughout the range of operating temperatures. It comprises two ring parts of metals having different coefficients of thermal expansion. That on the inside of the other has the higher coefficient and the two parts may either be separate or inseparably connected. The outer ring is of spheroidal graphitic cast iron or malleable cast iron and the inner may be aluminium alloy or magnesium alloy.

By selection of metals and appropriate design, it is possible to ensure that the ring pressure in the cylinder is relatively low when the engine is cold and relatively high when it is hot, as is most advantageous for lubrication. The light alloy ring, located inside the iron ring and in the piston ring groove, is protected from excessive thermal and mechanical stresses.

It is a feature of the design that both rings are of simple rectangular cross section. In the examples illustrated, ring A is of cast iron and ring B of light alloy. The rings may be produced separately and



No. 724936

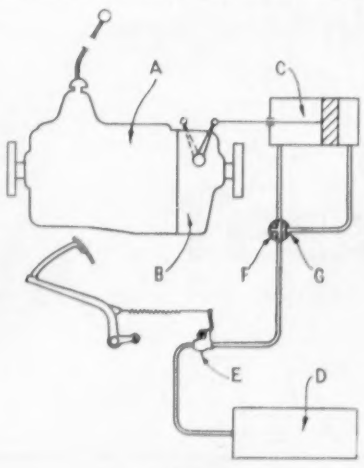
may remain separate or be joined together by soldering or brazing. Alternatively, the composite ring may be machined from a bi-metallic pot.

In the modified design, the light alloy ring C is located in a shallow groove in the inner face of cast iron ring D. *Patent No.* 724936. *Daimler-Benz A.G.* (*Germany*).

Gear-change mechanism

TO enable the best use to be made of engine power in relation to load, gradient and speed, some commercial vehicles are provided with a transmission including a main gearbox and a subsidiary two-speed unit, each of which is controlled by a hand lever. In order to use all possible combinations of gear ratios it becomes essential in some instances to operate the two levers in succession, which is difficult to perform and takes a considerable time during which the vehicle is not being driven. This invention proposes a two-speed box, having no neutral position, that is operated by a fluid-pressure servomotor in accordance with the setting of a preselective control when the clutch is withdrawn.

In series with the main gearbox A is a two-speed (direct or reduced) box B controlled by a compressed air servomotor

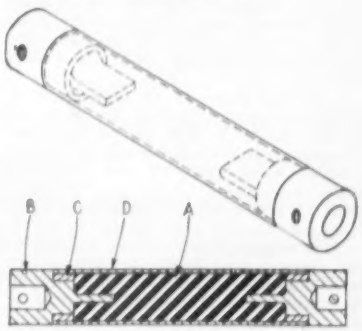


No. 722042

C. The supply of compressed air from storage tank D is past a control valve E, operated by the clutch pedal, and a two-position control F to either end of the servomotor C. This control may be a simple three-way cock with an escape duct G.

To operate the servomotor it is merely necessary, after preselecting the position of control cock F, to depress the clutch pedal. A change of ratio in the main box is effected by the usual lever. Thus, a single de-clutching operation and manipulation of a single gear lever are sufficient to give a simultaneous change of ratios.

Modified arrangements are described in the specification. In one, the servomotor is controlled by two electromagnetic valves preselected by a two-position switch and individually energized by a switch connected to the clutch pedal. The other has similar switching controls but the lever of the subsidiary unit B is operated directly by a pair of solenoid actuators. *Patent No.* 722042. *Société Nouvelle des Automobiles "Unic"* (*France*).



No. 720404

Torsionally resilient coupling

THIS coupling for coaxial shafts is claimed to accommodate large torsional deflections while providing a greater torque capacity than a bonded rubber assembly. Lateral stability is maintained by a metal sleeve enclosing the resilient element.

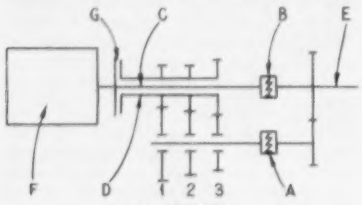
A solid cylinder A, of natural or synthetic rubber, is slotted at each end to engage tongues on metal end members B adapted to be fitted to the ends of the driving and driven shafts and secured by lock screws. Each member B has a reduced diameter to receive a self-lubricating bearing C on which the thin cylindrical metal casing D is supported.

This casing has an internal diameter slightly greater than the diameter of the rubber cylinder A in order to permit relative movement. A suitable lubricant, a silicone fluid for example, is introduced between the two to prevent fretting of the rubber. The casing is thus freely rotatable with respect to the rubber cylinder and the metal end members. In operation it prevents displacement of the rubber and lateral deformation of the coupling. *Patent No.* 720404. *Dunlop Rubber Co. Ltd.*

Free-wheeling transmission

WITH this arrangement the advantages of easy gear changing and of fuel economy associated with a free-wheeling transmission are retained but the disadvantage of the lack of engine braking effect on the over-run is largely eliminated. Two uni-directional clutch devices are incorporated and arranged to transmit a drive in opposite directions. These are conveniently disposed on, or aligned with the mainshaft and layshaft of the change-speed gear unit.

In the diagram the free-wheel devices are shown as ratchet-toothed dog clutches, but any suitable roller, sprag, or frictional type may be employed. The normal free-wheel device A is located in the layshift and is effective in all three gear stages, 1, 2 and 3. A reverse-direction free-wheel device B is disposed in a drive



No. 720259

shaft C, concentric with the hollow main shaft D, and couples the propeller shaft E directly with engine F, by-passing the change-speed gearing and the main clutch G.

A normal drive in all three gears is transmitted from engine to shaft E by free-wheel A. On the vehicle over-run this drive is interrupted and upon relative acceleration of the propeller shaft, or relative deceleration of the drive shaft C, free-wheel B transmits a drive from the propeller shaft to the engine.

It is suggested that engine braking in the highest gear ratio is adequate for normal operation. Should engine braking on lower ratios be desired this may be obtained either by fitting a locking arrangement to free-wheel A or by excluding the lower gears from the over-running action of free-wheel A. *Patent No. 720259. F. Nallinger (Germany).*

Compound piston rings

AN earlier patent, No. 674438, described a compound piston ring having an inner, heat-resistant, layer of steel and an outer layer of a metal having good sliding properties. A lead-bronze layer was intimately welded by immersion casting on to a steel sleeve which then, in the rough-machined condition, was subjected to a uniform pressure treatment on its inner face. Individual rings were severed from the sleeve and split after the external diameter was finish machined.

As an improvement, the patent under review proposes so to arrange the thickness of the outer layer and the resilience of the steel layer, by pressure treatment and selection of material, that as the outer layer is reduced in thickness by wear in operation its compressive effect on the inner layer is correspondingly reduced and, consequently, the radial pressure of the compound ring on the cylinder wall is not diminished. It may, in fact, be increased. A test showed that a compound ring 3 mm thick, with an outer layer of 1 mm, exerted a radial pressure of 3 kg at the end of the running-in period and 10 per cent higher after the vehicle driven by the engine had been run 6,000 km.

Experience has established that it is expedient to use a relatively soft outer layer and accordingly the B.H.N. of the lead bronze should be about 20 to 25. With a soft outer layer the radial pressure of the compound ring can be relatively low and a pressure of 2·5 kg is usually sufficient.

The resilience of the steel ring makes it possible to increase the thickness of the compound ring to about 50 per cent greater than a conventional cast-iron ring. Consequently, a thicker outer layer can be used, giving a substantial increase in working life while maintaining a virtually constant radial pressure. *Patent No. 720576. A. Monzer (Germany).*

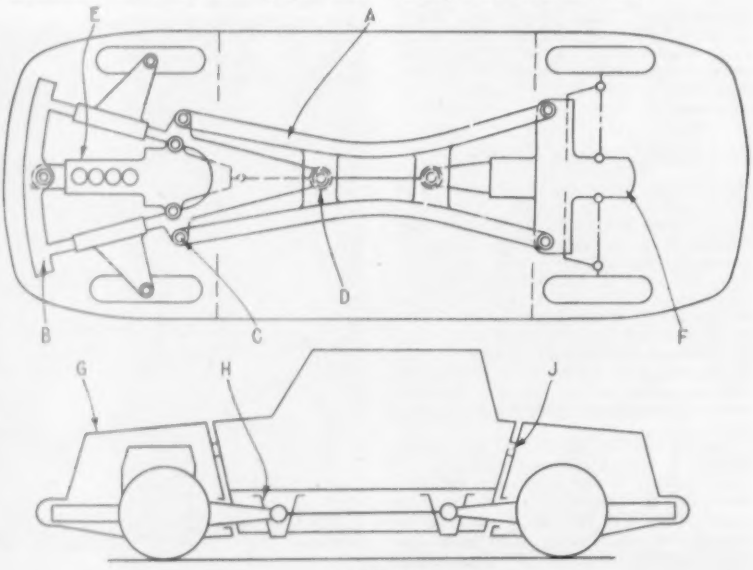
Mounting axle assemblies

THE trend towards the grouping of structural and mechanical elements into large sub-assemblies in order to facilitate final assembly is continued in this invention, which is applicable to either unitary or multi-cell vehicles. Axle assemblies, complete with suspension and engine and gear unit at the front, and transmission unit at the rear, are each supported cantilever fashion from the middle part or middle cell of the structure.

In one example of a vehicle to receive a one-piece body, the middle part comprises a frame A from which the front axle assembly on a triangular frame B is supported at two outer points C and an inner point D. Engine unit E has a 3-point resilient mounting on frame B. The rear axle assembly F, incorporating a torsion bar suspension, is attached in similar manner.

For a 3-cell vehicle each axle assembly is enclosed in a casing G to form an end cell. The inner support points are arranged on transverse bearers H on the middle cell and the outer support points J are constructed as coupling elements between the cells.

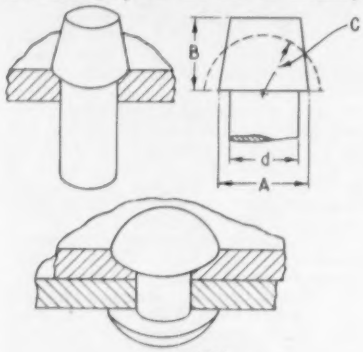
The specification also discloses a vehicle in which the extensions of the axle assemblies are dimensioned to meet at a common central support point, and a 3-cell vehicle having the axle assemblies articulated at their inner points and resiliently supported at the outer points. *Patent No. 721327. Daimler-Benz A.G. (Germany).*



No. 721327

Cold riveting

A TENDENCY has been observed in cold-set rivets of mild steel for the preformed head to be brittle at its junction with the shank and to break away in course of time. The head formed by riveting in position in the work is, in general, immune from this defect. By the use of rivets made of special "non-ageing" steel the difficulty can be largely obviated, but at some increase in cost and some decrease in availability. The invention proposes the use of ordinary



No. 722010

mild steel, or other alloy, which is subject to ageing, and the simultaneous formation of both heads by riveting.

The rivet is made from a length of rod and slightly upset to form a shoulder located substantially in the position occupied by the operative face of a conventional preformed head. In a typical, but not exclusive, example of a rivet having a shank diameter d, the upset has a diameter A of 1·3 d and a length B of 1·0 d, while the finally formed head has a radius C of 1·75 d. As an incidental advantage of the method, it is claimed that the riveted heads have a better peripheral engagement with the work than is the case with an ordinary preformed head. *Patent No. 722010. Rubery Owen and Co. Ltd.*

*'Syndromic' Automatic Lubrication soon pays for itself!

*INCREASES YOUR PAYLOADS 10%

From the moment you equip your vehicle with 'Syndromic' Lubrication it begins to pay for itself! First, it saves up to 75% on lubrication costs. Then, it ensures less wear on bearings because it automatically lubricates up to 80 bearings (using 2 pumps) at periods controlled by mileage. As a result, maintenance and replacement time and costs are kept down to a minimum.

But besides all that, 'Syndromic' lubrication saves the hours spent in the service bay. *It lubricates while the vehicle is working*, allowing you to increase your vehicles' payloads by as much as 10%!

It's obvious that 'Syndromic' lubrication soon pays for itself!

Ask for a Tecalemit technical representative to call and discuss the 'Syndromic' system with you.

TECALEMIT

The Authority on Lubrication

PLYMOUTH, ENGLAND

T416

CONCENTRIC MANUFACTURING CO. LTD.

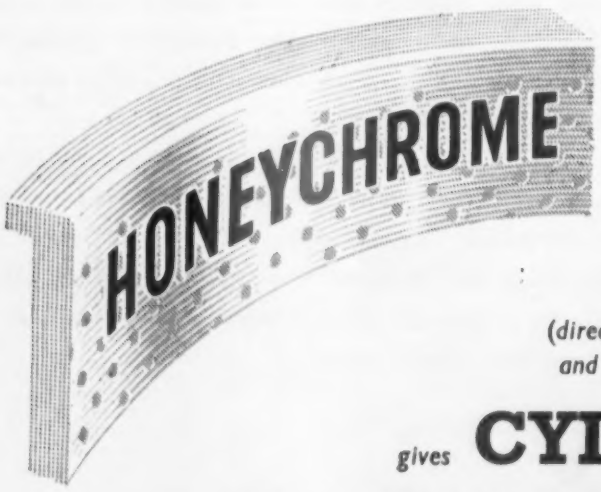
The Directors of the above Company wish to announce that they have acquired 98¼% of the Issued Ordinary Share Capital of Fletcher Bros. (Pressings) Limited, Handsworth, Birmingham.

It is considered that the acquisition should strengthen the manufacturing division of Concentric Manufacturing Co. Limited relative to the Motor Industry, and that the integration of technical experience and production facilities should be of advantage to both Companies.

The business will continue under its existing management, with Messrs. W. B. Fletcher and H. H. Fletcher, as Joint Managing Directors. Messrs. S. G. Morgan, H. Burke and G. Roland Dawes (Directors of Concentric Manufacturing Co. Ltd.) have joined the Board of Fletcher Bros. (Pressings) Limited and Mr. H. Burke has been elected Chairman.

Arrangements have been made to ensure the continuance of supplies to the existing customers of Fletcher Bros. (Pressings) Limited.

The Directors will have much pleasure in recommending at the next Annual General Meeting that Mr. J. G. Perks and Mr. F. R. Humphrey of the Executive Staff of the Priory Road and Tyburn Road Works respectively be appointed to the Board of Concentric Manufacturing Co. Ltd.



Cellular

Hard Chromium

Plating

(directly deposited on all metals and alloys, except magnesium)

gives **CYLINDERS**

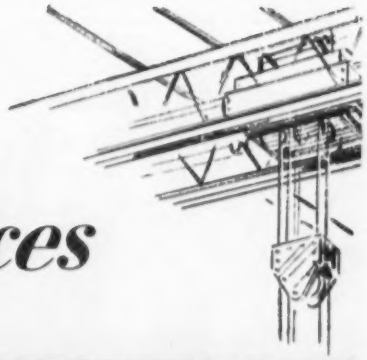
up to **500% LONGER LIFE**

Get full details without delay from—

MONOCHROME LTD. *Studley Rd., Redditch, Worcs.*

Telephone: STUDLEY 121/2/3/4

Redifon
R.F. Heating Services



A NOTABLE CONTRIBUTION TO MOTOR PRODUCTION

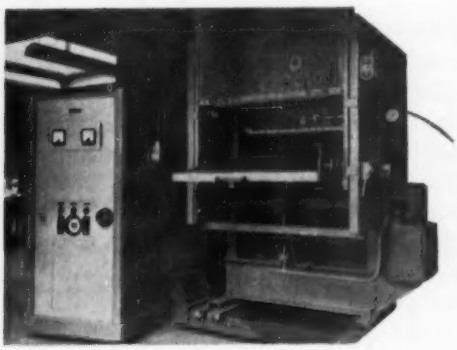
✳ *in the heat treatment of metals*

Redifon are today providing the most complete R.F. heating services to industry. As used by the leading automobile manufacturers, the application of these services is a wide one, and embraces the hardening of valve rockers and tappet screws, rocker shafts, starter ring gears and valve rockers after local carburising . . . local annealing of door panel pressings and tappet covers . . . annealing camshaft gears after carburising and hardening . . . silver brazing petrol filler assemblies . . . soft soldering petrol tank fittings and fixing clips to bonnet flutes. Melting battery connectors, glueing, shrinking, upsetting, and drying are applications of this comprehensive service.

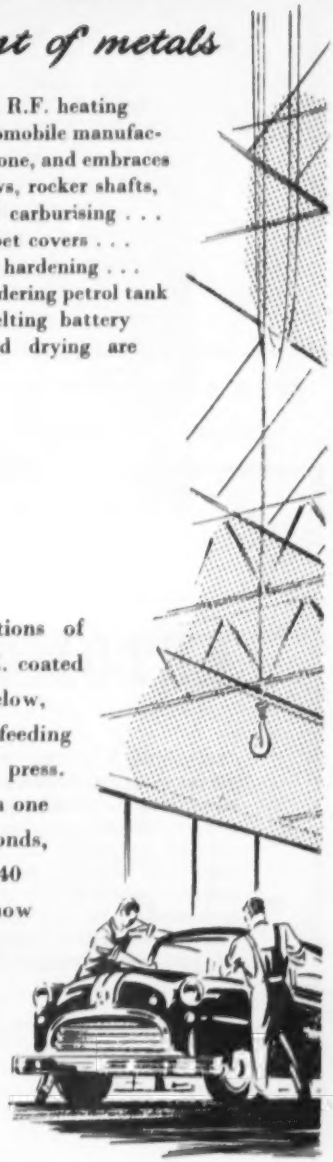
IH.39 9kW. generator fitted with work bench for simultaneous annealing of two camshaft gears supplied to the Austin Motor Co.

✳ *in the welding of P.V.C. materials*

One of the most important and technically interesting applications of Redifon R.F. Heating is the welding of upholstery made from P.V.C. coated fabrics. A typical installation for welding a car door trim is shown below, with a Redifon 6kW. RH16 feeding coaxially a 15 ton hydraulic press. Complete door trims are welded in one operation in approximately 20 seconds, giving a floor to floor time of 30 - 40 seconds. Similar techniques are now being developed for welding seat backs, using more powerful machines. Write to Redifon for full details of these and other welding and trimming applications.



RH16 at Vauxhall Motors



Industrial Electronics Division

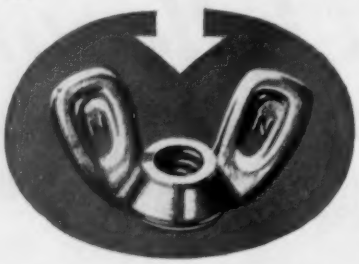
REDIFON LIMITED, BROOMHILL ROAD, LONDON, S.W.18. Phone: VANdyke 7281

A Manufacturing Company in the Rediffusion Group

WING NUTS? HELP YOURSELF...

Help yourself and help the job as well, whatever it may be. When it comes to wing-nuts GKN make two types which between them fit most requirements. The best way to help you is to give you the choice...

GKN Cold-forged Wing Nuts (Nettlefolds Parker-Kalon) are by now a world standard. Designed for maximum strength, free from rough edges, they are available in steel, brass, nickel, chromium, brassed and zinc finishes, and can be supplied in special finishes as well (quantity permitting).
In Whitworth, BSF, BA, UNC, and UNF threads (or in special tappings for quantity).



GKN Die-cast Wing Nuts are light and rustproof. The material is zinc alloy. Smooth, accurate, corrosion-resistant, they are clean cut to close tolerances. The alloy takes any commercial finish. Note the new recessed finger-grip.
In Whitworth, BSF and BA threads (or in special tappings for quantity).

If it's a matter of joining one thing to another . . . get in touch with **GKN**

GUEST KEEN & NETTLEFOLDS (MIDLANDS) LTD. Screw Division, Box 24, Heath Street, Birmingham, 18
s/w.1/2208

An invaluable work for both student and practical engineer

AUTOMOBILE CHASSIS DESIGN

This volume, by R. Dean Averns, provides a comprehensive survey of all the fundamental aspects of automobile design apart from the prime mover. The greatly-enlarged second edition contains new chapters on the techniques of independent suspension and chassisless construction, together with much new material on methods of stress measurement, anti-corrosive treatment of metals, road spring design and streamlining. Much of the emphasis is on problems of the heavy commercial or public service vehicle, but in general the work is equally applicable to the lighter field of car design.

Published for "AUTOMOBILE ENGINEER"

Contents Include :

Vehicle performances—Vehicle Suspension —Elements of Independent Suspension— Front Axles — Steering — Vehicle Braking and Performance—The Frame—Chassisless Construction — Measurement of Stress — Materials Anti-corrosion Treatment — Road Springs — The Transmission — The Gearbox — Rear Axles — The Differential — The Chassis.

2nd Edition 30s. net. By post 30s. 8d.

Available from all booksellers or direct from

Iliffe & Sons Limited, Dorset House, Stamford Street, London, S.E.1.

GLACIER

Bearings and Bushes

We make an astonishing variety of plain bearings. In fact, more than 3,000 different designs of bearings and bushes are going through our factories at any given moment. We supply thin-walled bearings to the motor industry and other engine builders, thick-walled and heavy bearings to the makers of compressors, pumps, turbines, rolling mills, marine and stationary diesels. In short, we make all types of bearings for all industries.

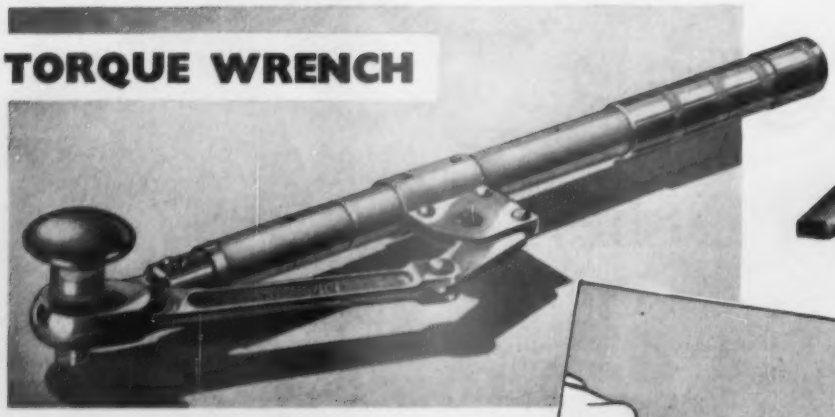
THE GLACIER ORGANISATION includes 3 production factories, 3 service stations; over 347,000 square feet of floor area, employing nearly 3,000 people, producing bearings and bushes in sizes from ¼" to 4 ft. diameter, in value from 2d. to £200 each, serving thousands of customers in engineering and many other industries all over the world.

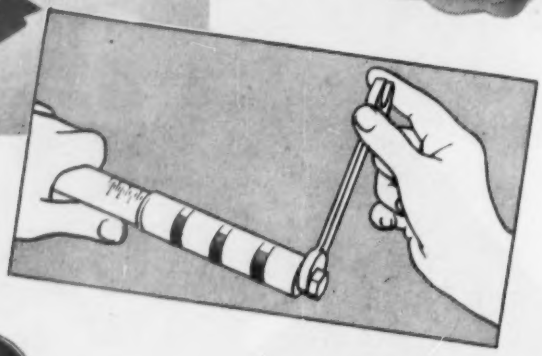
GLACIER

stands for all plain bearings

THE GLACIER METAL COMPANY LIMITED, ALPERTON, WEMBLEY, MIDDLESEX, ENGLAND

TORQUE WRENCH





Equip with KING DICK !

Incorporated in the King Dick Torque Wrench is a ratcheting head which enables continuous tightening of bolts and nuts without the usual removal and replacement —a distinct advantage and time saver. All working parts are made from Chrome Vanadium Steel and heat treated, ensuring long life. Literature is available which provides a schedule of recommended torque readings— please ask for copies or your local stockist will be pleased to give you details.

Our new 80 page catalogue is now available. Please write to Dept. A.E. for your copy.

ABINGDON

KING DICK

ABINGDON WORKS · KINGS RD · TYSELEY · BIRMINGHAM 11 · ENGLAND

R/C 185

THE GAP AND THE SCRAP

The Prime Minister and the Chancellor of the Exchequer have called for more exports and less imports to close the Trade Gap.

Every year, hundreds of thousands of tons of Scrap vital for steel-making are imported from abroad.

Every additional ton of Scrap produced at home means a ton less of imported Scrap.

You can help to bridge this gap by combing your works for every possible ton of idle Scrap, obsolete Plant, and unwanted Steel Structures.

Offer it all to us. We will quickly make it fit for re-melting and rush it to the Iron and Steel works, which need it so badly.

GEORGE COHEN THE 600 GROUP OF COMPANIES

SONS AND COMPANY LIMITED

ESTABLISHED 1834

RAW MATERIALS DIVISION

BROADWAY CHAMBERS, LONDON, W.6. *Telephone:* Riverside 4141. *Telegrams:* Coborn, Telex, London. And at 600 Commercial Road, E.14. Bidder Street, Canning Town, E.16. Bath, Belfast, Birmingham, Hebburn-on-Tyne, Leeds, Luton, Manchester, Sheffield, Swansea.

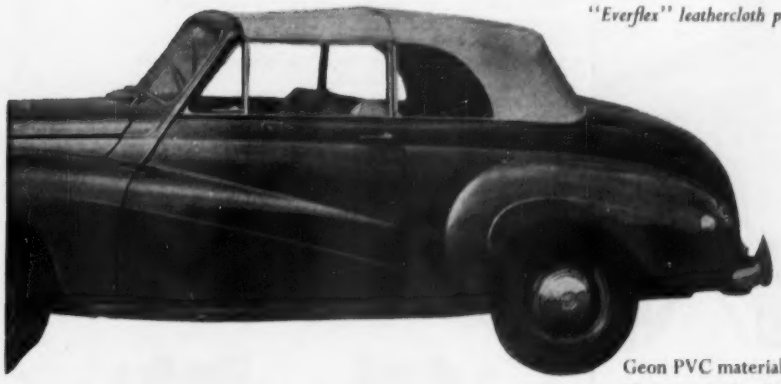
GCS/RM

DAIMLER...

CHOOSE GEON PVC

The "Conquest" — latest model in the Daimler range —
incorporates a power-operated hood in Everflex leathercloth
made with Geon PVC. This handsome material withstands all weathers
without cracking, flaking or perishing, even after years of use . . .
and needs only an occasional wipe with a damp cloth
to keep it always in immaculate showroom condition.

"Everflex" leathercloth produced by Bernard Wardle (Everflex) Ltd.



Photograph of Daimler 'Conquest' by courtesy of The Daimler Co. Ltd.

Geon PVC materials are polyvinyl chloride plastics.
Please write for descriptive Booklet No. 116, free on request.

BRITISH GEON LIMITED

Sales & Technical Service:—

DEVONSHIRE HOUSE · PICCADILLY · LONDON · W1 TELEPHONE: MAYFAIR 8867

Geon
Polyvinyl Materials

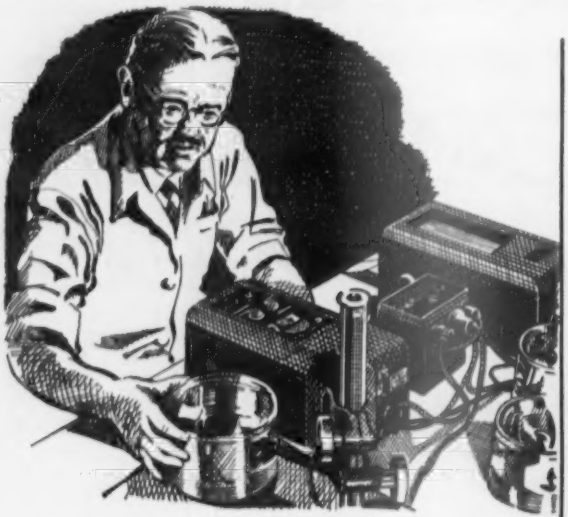
'Geon' is a reg'd Trade Mark

COPPER commands confidence

From the planning of a job to its completion there is confidence all the way when copper is used. Those who specify it, those who fabricate it, and those who finally use it in service, all know that copper means a permanent job well done.
For economy and efficiency in the application of copper and its alloys use the advisory service of the C.D.A. This entirely free service exists to help copper to help you.

FIRST ASK THE C.D.A.

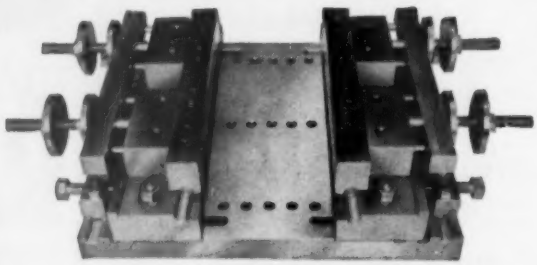
COPPER DEVELOPMENT ASSOCIATION · KENDALS HALL · RADLETT · HERTS · RADLETT 5616



KEMSON

PRECISION
and Accuracy...

These are the qualities that are such a vital part of modern machine shop practice. Electronic instruments now prove tolerances that may be measured only in millionths of an inch—and this on work in quantity production.
Such amazing standards have only been achieved because "not quite" has never been good enough for the tool maker.
Kemson engineers have for many years shared in the evolution of such accuracy and today it is true to say their craftsmanship is unexcelled anywhere.
Kemson are specialists in the production of Jigs, Tools, and Fixtures suitable for the aircraft and motor industries and in the manufacture of Drop Hammer Dies. In addition capacity is available for jig boring.
Please write for full information.



KEMSON ENGINEERING CO., LTD.
ATLAS IRONWORKS · BLACKBURN LANCS TELEPHONE: BLACKBURN 7186

HENRY BERRY & CO. LTD.
1883—1955

We remind you that we are one of the oldest Hydraulic Manufacturing Companies in Britain and we make all the most modern equipment for every branch of British Industry. All Engineering and Industrial undertakings of repute in Britain and beyond the seas are our customers.

Our standard lines of products include

HIGH PRESSURE HYDRAULIC PLANT FOR SHIP-YARDS AND RAILWAY WORKSHOPS, HYDRAULIC PRESSES, PUMPS, ACCUMULATORS, VALVES AND INTENSIFIERS, PLATE BENDING ROLLS, PUNCH-ING AND SHEARING MACHINES, CONTINUOUS FINISHING PRESSES FOR SILKS AND RAYONS, VENEER AND PLYWOOD PRESSES, GLUE SPREADERS, GLUE MIXERS, COTTON BALING PRESSES, DIE SPOTTING PRESSES

★ In addition we design and make special tools both mechanical and hydraulic for all industries.

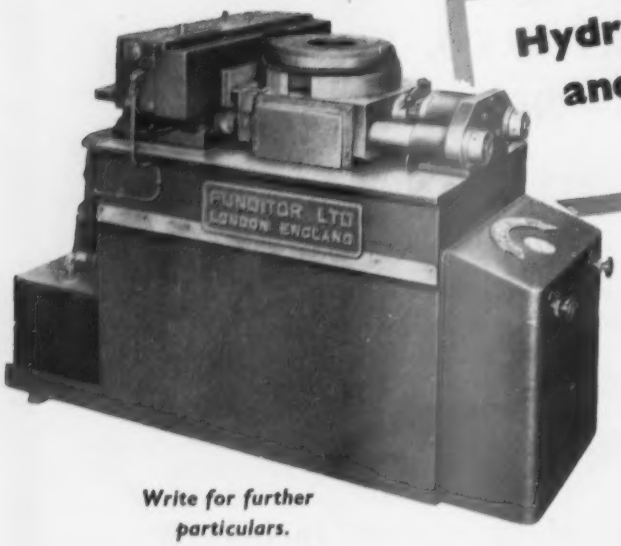
72 years of progress.

HENRY BERRY & CO. LTD.
CROYDON WORKS, LEEDS, 10

Telephone: 75481-2 Telegrams: "Rivetter Leeds 10"

FUNDITOR

Hydraulic flange marking and flywheel graduating machine . . .



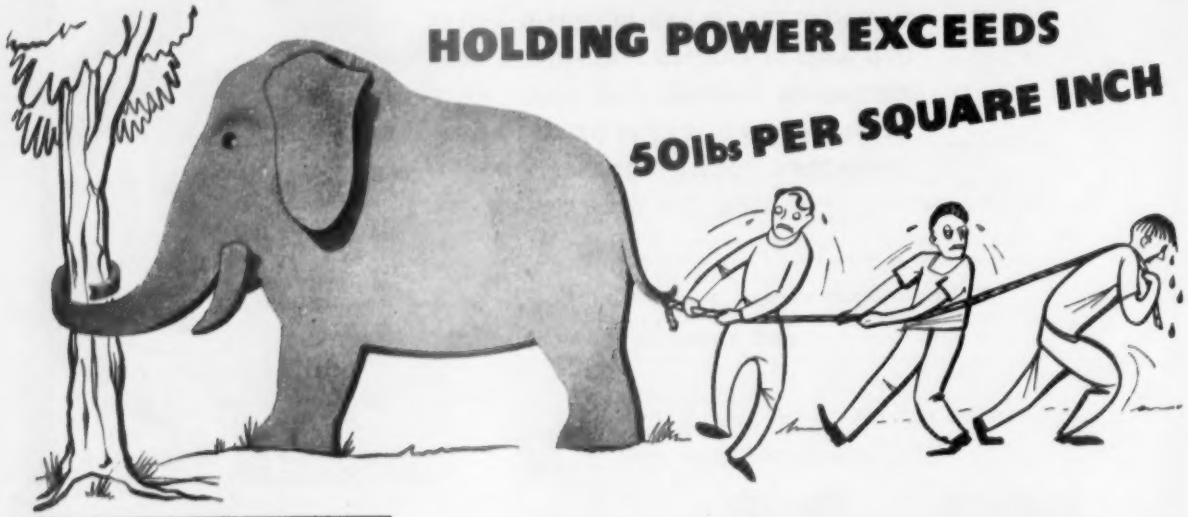
Write for further particulars.

Specially for marking large pipe flanges and graduating flywheels in the automotive industry, this FUNDITOR machine has sychronised hydraulic operation of marking slide and sliding table. For extra deep marking, an automatic repeat device is incorporated. Instrumentation consists of pressure gauge, pressure regulating valve, and switch for single, double or repeat marking, giving a simplicity of control which permits maximum production by unskilled operators.

3, WOODBRIDGE ST., LONDON E.C.1
TELEPHONE: CLERKENWELL 6155-57 TELEGRAMS: FUNDITORS CENT LONDON

Funditor Ltd

HOLDING POWER EXCEEDS 50lbs PER SQUARE INCH

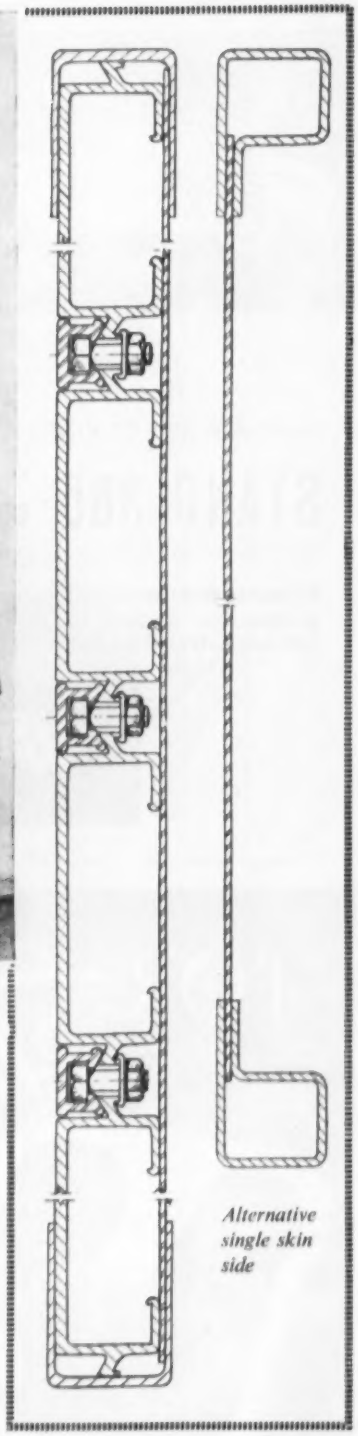


CROID 65
MACHINE FIXING GLUE
COOPERS FELT

More than 1,000 factories have done away with bolts, grouting, damaged floors; made layout changes a matter of hours; practically eliminated machine vibration. How? By adopting the Croid-Cooper method of machine installation where machines are stuck down on a felt base with a holding power of 50 lbs. to the square inch.

COOPER & CO., (B'HAM) LTD., BRYNMAWR, Breconshire.
Telephone: Brynmawr 312.

Engraved on "Primag" magnesium alloy plate



Alternative single skin side

Body sections— doing the most with the least

THE answer to the vehicle builder's long-expressed needs, BIRMETALS designs reduce to the minimum the number of different sections needed for building a body, since they can be adapted to the various parts of the structure.

Interchangeable sections in widths of 3½" and 8¾" are used to build both sides and floors. They are joined with a special locking section which has the great advantage that when the assembly is bolted together there is no protrusion of the bolt head. If required, floor surfaces can be either studded, ribbed, or both.

The possibility of locking the floor sections together between the bearer supports results in an amazingly rigid floor which will withstand dumping by grab loading.

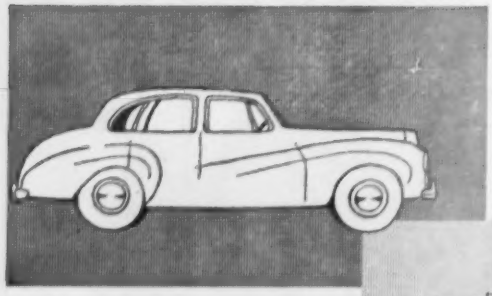
Write for our free leaflet.

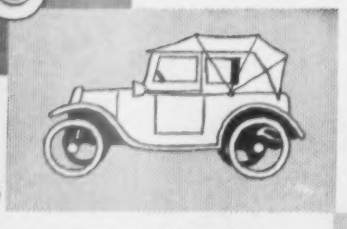
BM 46

Birmetals

Pioneers in Light Alloys

BIRMETALS LIMITED · BIRMINGHAM 32 · BIRMABRIGHT LIMITED





New or old . . .
WELLWORTHY helps your car

Many of the new cars you will see at the Motor Show are already fitted with the famous Wellworthy Pistons, Piston Rings and other products. But Wellworthy can help to improve the efficiency of your present car too—whatever its make or age.

MAKE A POINT OF VISITING

STAND 385 for full particulars of the famous **DUAFLEX OIL CONTROL RINGS**

which reduce oil consumption, increase compression, defer rebores.

Wellworthy Products include: Pistons · Piston Rings · Cylinder Liners Gudgeon Pins · Circlips · Die Castings · Valve Seats · Wellseal Jointing Compound. **You will see also the new Wellworthy Ricardo Supercharger.**

WELLWORTHY
'THE CHOICE OF THE EXPERT'

Wellworthy Limited · Lymington · Hants

FOR
Diecastings as strong as steel
ALUMINIUM BRONZE CO. LTD.
Wallows Lane · Walsall · Staffs.
Telephone WALSALL 2108 (3 lines)
Telegrams "ABCO WALSALL"

Do not disturb

Can two hands do the work of four — or six — or more? Does increased production necessarily require more man-power?
Can life be made more attractive and easy for my present operators?
These are questions often asked by harassed production executives in practically every industry, and the lucky ones find the answers they want in Enots several booklets explaining in fullest detail the advantages of controlled air power in the factory.
Automate with Enots and British Bellows Pneumatic Equipment NOW! Our technical representatives are ready to advise you on your particular problems — and without the slightest obligation of course.

Two short films "Production Miracles" and "Operation Push Button" produced by the Bellows Corporation of Akron, Ohio, U.S.A., and illustrating the application of pneumatic devices as aids to increased production and efficiency, are available for exhibition on application to Benton and Stone Limited.

Enots and BRITISH BELLOWS

PNEUMATIC EQUIPMENT

BENTON & STONE LTD., ASTON BROOK ST., BIRMINGHAM 6, ENGLAND

WE are privileged to number among our clients many of Britain's most famous car and commercial vehicle manufacturers. When next you require non-ferrous Sand Castings, Gravity Die Castings and Pressure Die Castings of the highest quality and precision, and keenly competitive in price — LET SANDWELL QUOTE. Our Technical Representative in your area will be pleased to call and discuss your requirements.

★ ILLUSTRATED LITERATURE ON REQUEST

SCC

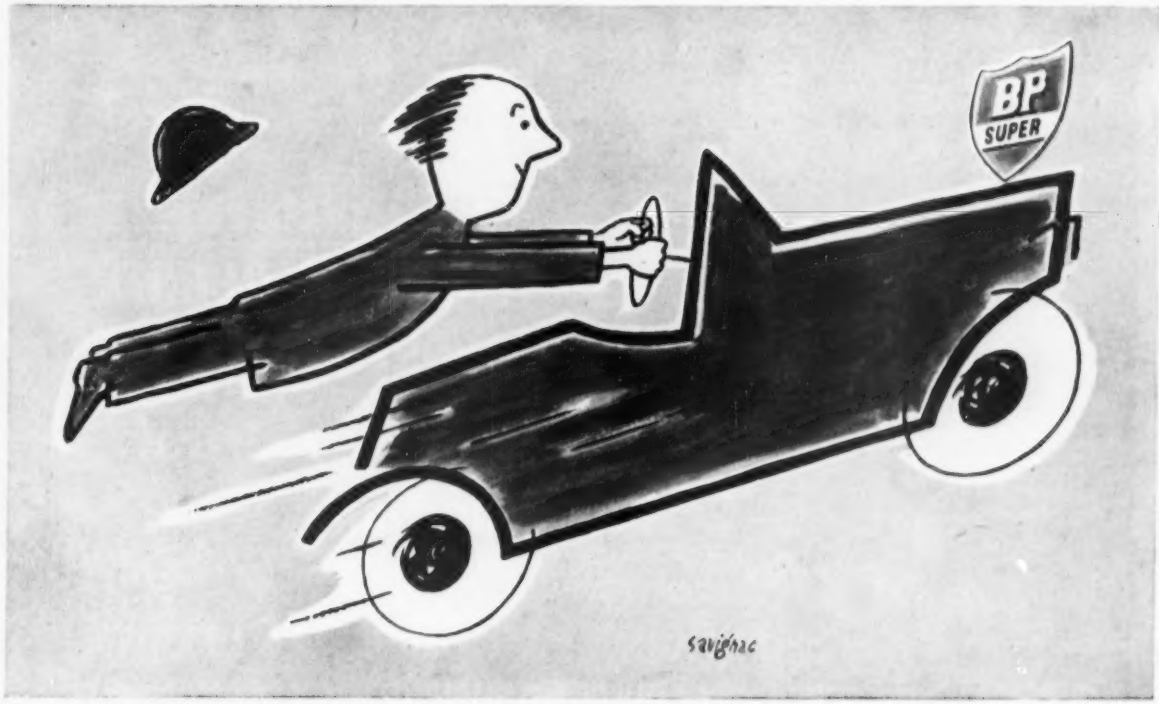
THE SANDWELL CASTING CO.
BANK ST. FOUNDRY, WEST BROMWICH
Telephone : STOnecross 2231 (4 lines).
Telegrams : "REPCAST, WEST BROMWICH"

it's all very well but...

When a pieceworker starts on 'ifs' and 'buts' about press guards, it is time you asked UDAL about the famous 'Fastrip' Synchronised Guards for *increased* production and *increased* safety. The 'Fastrip' is worked by compressed air and guard and clutch are synchronised to ensure split-second timing. Send for details today.

J. P. UDAL
LIMITED
INTERLOCK WORKS,
COURT ROAD,
BIRMINGHAM, 12
Telephone : CALthorpe 3114

Udal
PRESS GUARDS



New BP Super!

For more energy per gallon

NEW BP Super is the petrol with more energy per gallon. It puts new life into your car from the very first fill. No matter what make or year of car you own, you'll find it pulls better on new BP Super.

More 'Go'—and longer engine life

You'll notice livelier performance right from the start — because new BP Super is a smoother-burning petrol with greater freedom from engine-knock and more energy per gallon. You save money, too. New BP Super gives you more miles per shilling and keeps your car on the road longer before the engine needs overhaul.

Also, new BP Super is specially blended for winter use. It prevents stalling, loss of power and the high petrol consumption caused by carburettor icing.

Photograph by courtesy of "Motor Racing"

Mercedes take first three places at Dundrod

Successes on new BP Super in RAC International T.T.

In the fastest T.T. of all time, Stirling Moss came first with an average speed of 88.32 m.p.h., and second and third places were taken by J. M. Fangio and G. von Tripps. All three were driving Mercedes Benz 300 SLR cars, using new BP Super. It shows what superb performance you can get from a super petrol. Whatever your car, new BP Super gives you greater freedom from engine-knock and more energy per gallon.

BP SUPER

Change up to new BP Super!

it's specially blended for winter use

The BP Shield is the trade-mark of THE BRITISH PETROLEUM COMPANY LIMITED

SERVICING GUIDE

to British Motor Vehicles

VOLUME 3

- A new volume of this unique book of standardized Service Data

SUPPLIES STRICTLY LIMITED
ORDER NOW! £2 10s. Post 1/6
in United Kingdom

Following the very wide success of the previous volumes of the Servicing Guide, this latest publication brings up-to-date the information on the vehicle and engine servicing of many 1953-54 and some 1955 models. Bound in a single volume and arranged alphabetically in three groups by makes (cars, commercial vehicles, tractors and components), 25 of the eight-page supplements and three four-page supplements published in Motor Trader and British Automobiles Overseas provide an unequalled range of complete information.

General tuning, overhauls and maintenance receive a thoroughness of treatment not available from any other source, as the bulk of the information has been obtained by personal research among the vehicle manufacturers. Ten of the new style Service Sheets use the "exploded" view technique to demonstrate the assembly and function of major components. Comprehensive wiring charts, specially compiled conversion and reference tables, illustrated glossary of technical terms and a revised treatment of tabular matter provide even more complete and more easily followed information.

Volume 3 covers these vehicles and components:—Alvis: Three-Litre. Armstrong Siddeley: Sapphire. Aston Martin: DB2. Austin-Healey: Hundred. Daimler: Conquest and Century. Ford: Anglia and Prefect. Humber: Hawk Mk. VI, Super Snipe Mk. IV. Jowett: Jupiter. Lanchester: Leda and Fourteen. M.G.: Magnette. Morris: Minor Series II, Six. Renault: 750. Singer: SM Roadster. Triumph: TR2 Sports. Wolseley: Four-Forty-four. Bedford: 10/12-cwt. Van, Ta Middleweight Range. Commer: Superpoise Mk. III. Dennis: Centaur. Morris-Commercial: NVS and FVS. Nuffield: Tractor. Thames: 2- and 3-Tonner. Hardy-Spicer: Universal Joints. Laycock-De Normanville: Overdrive. Perkins: R6 Diesel Engine. S.U.: Electric Fuel Pump.

TRADER PUBLISHING CO. LTD.,
DORSET HOUSE, STAMFORD ST., LONDON, S.E.1

SPECIAL IRONS demand the use of INDUCTION MELTING FURNACES

G.W.B.-A. Tagliaferri Induction Melting Furnaces give :—

- ACCURATE CONTROL OF TEMPERATURE AT ALL CHARGE CONDITIONS.
- CLOSER CONTROL OF ANALYSIS.
- COMPLETE ALLOYING AND HOMOGENEITY OF MELT BY THE MECHANICAL MOTION OF THE BATH.
- REDUCTION OF HARMFUL INCLUSIONS THROUGH CLEANER OPERATING CONDITIONS.
- MAY BE SWITCHED OFF OVER WEEK-END, THUS ENTAILING NO STAND-BY LOSSES OR SUPERVISION.

For normal and special cast irons standard sizes of G.W.B.-A. Tagliaferri furnaces are available for molten metal outputs of 140 to 2,000 lbs. per hour. Particularly suitable for thin wall castings, the furnaces can operate from cupola melted molten metal, or melt from cold. A standard range of induction furnaces is also available for light metal alloys having outputs of from 100 to 1,750 lbs. per hour and for copper and its alloys from 50 to 4,000 lbs. per hour. We will be pleased to quote for furnaces for special requirements.

GWB-A. TAGLIAFERRI

Mains Frequency Core Type

INDUCTION MELTING FURNACES

G.W.B. FURNACES LTD.
Dibdale Works, Dudley, Worcs. Telephone: Dudley 4284
Proprietors: GIBBONS BROS. LTD. and WILD-BARFIELD ELECTRIC FURNACES LTD.

The Shop Foreman says...

FLETCHER MILLER

CUTTING FLUIDS

must have something—
see these screwed rods
for yourself.

For the record . . .
SWIFTEX
This well fatted straight oil has a high sulphur content. It is well suited for tasks where cutting loads, rate of metal removal or the physical properties of the material combine to produce very severe conditions, e.g. broaching, gear cutting and form tool work on high tensile steel.

Publication SP.173 describes the entire range of Fletcher Miller cutting fluids. May we send you a copy ?

FLETCHER MILLER LTD · ALMA MILLS · HYDE · CHESHIRE

Telephone : Hyde 781 (5 lines) Telegrams : Emulsion, Hyde

CF92

In the words of Shakespeare:

"But wherefore should I go ?"

"Merchant of Venice" Act II, Scene V

Shylock may have doubted the wisdom of accepting the Christian's invitation to supper, but there will be no doubt about your wisdom if you accept our invitation to use the "POP" Riveting System.

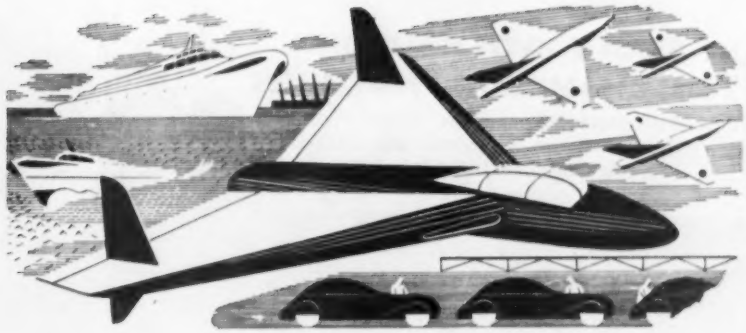
Requiring only one operation by one operator to set or clench the rivet, this modern system eliminates errors in setting, prevents distortion of the structure and enables rivets to be set in positions inaccessible by other methods.

Shylock accepted his invitation—will you accept ours?

"POP" RIVETING
ONE OPERATOR OPERATION

Geo. **TUCKER EYELET** Co. Ltd.
Walsall Road · **BIRMINGHAM 22**
Telephone : Birchfields 5024 (7 lines) Telegrams : EYELETS, BIRMINGHAM
Consultants & Tool Manufacturers :
AIRCRAFT MATERIALS LTD. Midland Road, London, N.W.1
"POP" is a regd. Trade Mark of Geo. Tucker Eyelet Co. Ltd.

THE MODERN SYSTEM OF RIVETING



WROUGHT TITANIUM

can you use it?

British Industry now has at its service

a new wrought metal—titanium.

Years of pioneer research and the development of special extraction and melting techniques by I.C.I. have heralded its debut in Britain. Now it is ready to revolutionise progress in our aircraft industry and in other engineering fields.

can you afford <u>not</u> to use it?

Titanium is only half the weight of steel. Alloys (I.C.I. is now producing a steadily widening range) can be made which, besides being phenomenally resistant to most forms of corrosion are as strong as many high-tensile steels.

Already, I.C.I. titanium and titanium alloys are available in sheet, strip, rod, tube, wire, plate and forging stock. I.C.I. will be pleased to advise on the known and potential applications of this new and outstanding material.

IMPERIAL CHEMICAL INDUSTRIES LIMITED, LONDON, S.W.1.

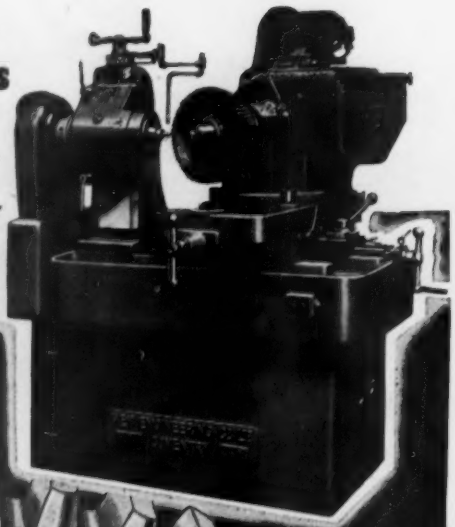
ICI

M389

HEY

GEAR TOOTH ROUNDING and CHAMFERING MACHINES

Automatic Operation, High Production Rates on External and Internal Gears, Starter Rings, etc.

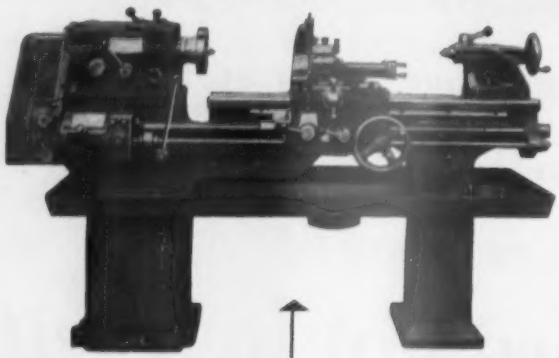


Used extensively by all leading gear specialists, automobile, aircraft, machine tool manufacturers, etc. Two models available for work up to 20in. and 10in. diameter. Illustrated data on request.

HEY ENGINEERING CO. LTD.
COVENTRY PHONE COVENTRY 88641

We also manufacture Rotary Cam and Profile Milling Machines, Short Thread Milling Machines, Multiple Drilling Heads and Machines, Tapping Machines, End Facing and Centring Machines, Special Machine Tools for High Production.

Rainbow



Woodhouse & Mitchell

'70' junior 7″ centre lathe

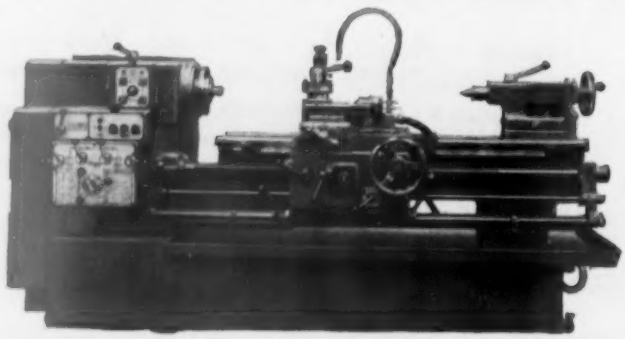
'85' 8½″ centre lathe

Proprietors: Thos. W. Ward Limited

WOODHOUSE & MITCHELL · Wakefield Rd. Brighouse. 'Phone 627

8 SPINDLE SPEEDS 30—874 r.p.m. Spindle mounted on selected taper roller bearings • Diagonally braced bed • Nickel steel gears on multi-splined shafts • Inverted vee and flat guides • Single lever selection of feeds • Tension mounted lead screw • Oil immersed multi plate clutch.

12 SPINDLE SPEEDS 21—945 r.p.m. Rigid one piece fabricated steel base • Rapid spindle speed selection • Feed reverse control from apron • Totally enclosed auto lubricated quick change feed gear box.



Send for fully illustrated booklet.

W.H.17.

For production of

CRANKSHAFTS

of every type

THE NAME IS

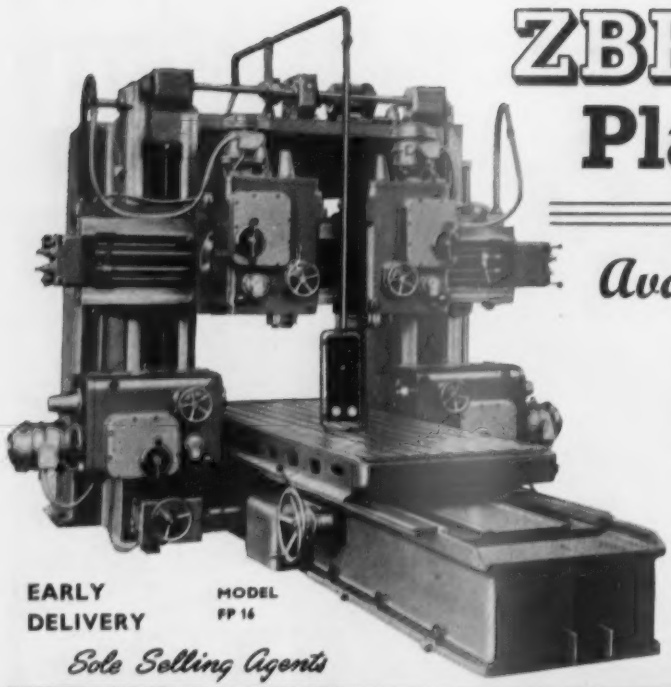
LAYSTALL

LAYSTALL ENGINEERING COMPANY LIMITED

Crankshaft Works, GREEN LANE, ALDERSLEY, WOLVERHAMPTON. **Tel. Wolverhampton 52006**

Head Office: 53, Great Suffolk Street, London, S.E.1

Laystall Laystall Laystall Laystall Laysta



EARLY DELIVERY MODEL FP 16

Sole Selling Agents

ZBROJOVKA
Plano Millers

Available in three sizes

FP 12 TABLE 38" × 118"

FP 16 TABLE 49" × 138"

FP 20 TABLE 63" × 157"

★ **Wide range of Spindle Speeds enabling use of high-speed steel and cemented carbide tipped cutters.**

★ **Table speeds infinitely variable.**

★ **Independent drive to individual headstocks, individual drive to table and headstock feeds.**

★ **Automatic clamping of cross rail to guideways.**

☛ ***Our Showrooms are only a few minutes from London Airport***

ELGAR *Machine Tool Company Limited*

HAMPTON ROAD WEST · HANWORTH · FELTHAM · MIDDLESEX

Phone: FELTHAM 4266. Cables & Grams: SHIPMENTS, FELTHAM

for perfect photo-prints

Wolff's **FERROPRINT**

the 'light-stopping' lead

There's never a shadow of doubt about the firm impression made by a Ferroprint pencil. Black uniform lines always — distinctly better for clear photo-print reproduction of fine detail. You save time and work too, because no inking-in is required. Specially made for you — so ask for it by name: Ferroprint.

Ferroprint solves your pencil problems.

- *Long-lasting point.*
- *Consistency of degree.*
- *Smooth, extra-tough lead.*
- *Light-stopping properties.*

Made by THE ROYAL SOVEREIGN PENCIL CO. LTD. LONDON N.W.10

AMAL

Component Specialists to the Motor Industry

AMAL LTD · HOLDFORD ROAD · WITTON · BIRMINGHAM 6

Unique

"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method.

C. P. Newall & Co., Ltd.

POSSILPARK GLASGOW · N

Photo: Courtesy Willenhall Motor Radiator Co., Ltd.

Press Tools & Stretcher Dies

AT A FRACTION OF THE COST using

KIRKSITE 'A'

LOW COST - SPEED - HIGH RECOVERY VALUE

Cost of dies made with KIRKSITE 'A' is only a fraction of those made of steel or cast iron, the more intricate the tool the greater is the saving. Use of KIRKSITE 'A' also means that dies can be produced in a few days eliminating long waiting periods for tools. A complete and speedy service for the production of both patterns and dies is operated. KIRKSITE 'A' data gladly sent on request.

Also the Hoyt Buyers' Guide, listing all the Hoyt products and services.

PRODUCTION RUNS OBTAINED FROM KIRKSITE PRESS TOOLS

Kirksite 'A' and Plastics: *Kirksite is specially suitable for metal moulds for Polyester resins, having a very long life under operating conditions with Polyesters, whether plain or reinforced.*

200,000	Petrol tank pressings in 20 gauge steel from one KIRKSITE punch.
60,000	Aircraft jettison tanks in 16 gauge steel.
20,000	Delivery van sides in 20 gauge steel.
20,000	Runs in aluminium alloy sheet without any appreciable wear on tools.
50,000	Special plastic helmets on one set of KIRKSITE tools.
25,000	Special rubber parts from a KIRKSITE mould.

All the above tools were still serviceable.

HOYT LONDON

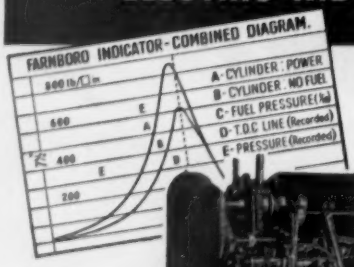
METAL CO. OF GT. BRITAIN LTD.

DEODAR ROAD, PUTNEY, LONDON, S.W.15.
Telephone: VANdyke 6061.

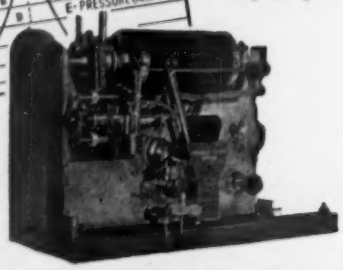
PLAIN BEARINGS · ANTI-FRICTION METALS
BRONZES & LEAD BRONZES · FUSIBLE ALLOYS, ETC.

DOBBIE McINNES

'FARNBORO' ELECTRIC INDICATOR



Large Diagrams up to 14½" × 7½"



No complex electric circuits. Replacements are negligible. No glass components. Simplicity ensures ready understanding and manipulation without special knowledge. Very large diagrams. No Photography, thus saving time and trouble. Calibration Lines can be recorded while taking Diagrams.

DOBBIE McINNES

DOBBIE McINNES LTD
Medical & Engineering Instruments
BROOMLOAN RD GLASGOW SW1
Also at SOUTH SHIELDS · LIVERPOOL · LONDON

This BLUEPRINT is Morane* PROTECTED

Cut your costs by protecting Blueprints, Notices, Documents, Bookcovers, Charts, Drawings, and all printed matter with Morane Transparent Heatsealing Plastic Skin.

- **WASHABLE HIGH GLOSS SURFACE**
- **INSTANTANEOUS FIRM BOND TO PAPER, CARDBOARD, ETC.**
- **CAN BE FIXED BY UNSKILLED LABOUR**

Plastic material now available for lamination of identification cards, calendars, price tickets, etc.
SEND NOW FOR FULL DETAILS OF

*Morane Transparent HEATSEALING PLASTIC SKIN

MORANE PLASTIC CO. LTD.
21 WOODTHORPE ROAD - ASHFORD - MIDDLESEX
Tel.: Ashford Middx. 2727 & 3391

SEEGER the Original CIRCLIP is 360° SAFE

Seeger Circlips are easily placed in position with the Seeger Circlip Pliers, and are just as easily removed.

Their scientific design and accurate manufacture ensure that they are perfectly circular when in position, thus exerting uniform pressure at all points on their periphery.

Because of their simplicity and safety, Seeger Circlips efficiently replace complicated methods of locating and retaining components in sleeves, housings and on shafts. While producing a sound, workmanlike assembly, they substantially save time and costs. Write today for technical data and price list.

AUTOMOTIVE ENGINEERING LIMITED

(One of the Sheepbridge Engineering Group)

The Green, Twickenham • Telephone: Popesgrove 2206-9 Telegrams: Motif, Twickenham.

OA/2124

TURQUOISE wins on every point

PRECISION GRADING

Turquoise gives exactly the line you want every time, because every one of the 17 grades—from 9H to 6B—is made from its own basic formula.

SMOOTHNESS

Turquoise smoothness speeds your work. Every particle of lead is lubricated with rare waxes, sealed in for permanent smoothness. No gritty flaws, no harshness.

OPACITY

100% Electronic graphite refined in the Eagle attrition mill to 1/25,000th" particles, produces a fine-textured lead that gives lines of maximum denseness for perfect reproduction.

STRONG POINTS

Turquoise points don't snap or crumble under pressure. The more compact lead—100% Electronic graphite again—takes and holds a needle point without crumbling.

CLEAN ERASURE

With Turquoise pencils there is no fear of "ghost" lines after erasure. Lines rub out cleanly every time.

EAGLE

'CHEMI-SEALED' *Super-bonded*

TURQUOISE

DRAWING PENCILS

with 100% 'ELECTRONIC' *Graphite*

16 EAGLE PENCIL CO., ASHLEY ROAD, TOTTENHAM, N.17

—BUT ARE THEY ALL ALIKE?

EVEN A PEA MAY HAVE A HIDDEN GRUB, AND SO IN COMPONENTS FOR ENGINEERING—

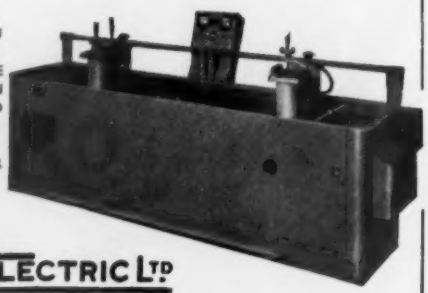
You can make certain of your own products being perfect by using—

FEL ELECTRIC

Electro-Magnetic Crack Detectors

THIS IS MODEL GP/U FROM OUR WIDE RANGE BUT WE CAN DESIGN AND MAKE TO YOUR PARTICULAR NEEDS

Send for Particulars



FEL ELECTRIC LTD

41 SIDNEY ST., SHEFFIELD 1

hypoid differential

MOSS GEARS

ENSURES INCREASED PASSENGER COMFORT COMBINED WITH MAXIMUM SILENCE

(Due to the "Below Centre" Pinion eliminating the need for floor tunnelling)

RANGE FOR 1½ to 3½ LITRE CARS

THE MOSS GEAR CO LTD · CROWN WORKS · TYBURN · BIRMINGHAM 24

'Phone: **ERDington 1661-6**

Grams: **Mosgear Birmingham**

giving him the cold shoulder!

Round about the time that Napoleon was meeting his Waterloo, English girls were doing their best to look like statues. They draped themselves in 'off the shoulder' high-waisted Grecian garments, which they damped, so that the material would cling to their figures. Men copied them by damping their pantaloons before putting them on and then drying them skin-tight.

The fashion at Ekco is to keep apace with the times in everything plastic. Designing, tooling and moulding—we do it all—'under one roof'. Whatever *your* problems in plastics, however large or complex, we have the know-how and experience to offer you the perfect solution. Get in touch with us at Southend!

EKCO plastics

E. K. COLE LTD. (*Plastics Division*), **SOUTHEND-ON-SEA, ESSEX.**
Members of the British Plastics Federation

Taking the strain!

Movement, vibration, power stresses, these forces provide a constant tug-of-war with every bolt and nut. That is why engineers use Richards "Hi-Strain" bolts which take such strains with maximum safety. Supplied Heat Treated to B.S.S. 1083 and B.S.S. 1768 Grade R Quality 45/55 tons tensile. Threads to Whitworth B.S.F., U.N.F. and U.N.C.

RICHARDS
hi-strain BOLTS

CHARLES RICHARDS & SONS LTD., Darlaston, South Staffs.
Phone: James Bridge 3188 (8 lines) P.B.X. Wires: "Richards, Darlaston."

FOR THE AUTOMOBILE INDUSTRY

Aerialite PRODUCTS

INCLUDE

AUTO CABLES

The first class electrical and mechanical specification of these cables for starting, lighting, charging and ignition ensures trouble-free service even under the most arduous conditions. Moreover, these cables are competitively priced so that high quality and economy are achieved in the installation.

INTERFERENCE SUPPRESSORS

The range of Aerialite ignition suppressors covers types for plug, distributor and lead fitting. Suppression of interference on T/V is most effective and these suppressors are specially designed for use where car radio is installed. Engine performance is unaffected.

IGNITION CABLES

Ashavin is the registered trade mark of the new Aerialite thermoplastic insulated ignition cable which is unaffected by ozone, petrol, water, grease, sunlight, etc. Ashavin is available in a wide range of brilliant colours and is low priced. Other ignition cables include rubber insulated and rubber, textile and lacquered types.

CAR AERIALS

The Model 16 is one of a wide range of car aerials which have been designed for fitting on the header, valance, mudguard, etc. The Model 16 is fully retractable and is extendable to 5' 0" above the mounting surface. It is capable of providing a high signal pickup with low noise level.

Please send for details of the above and other products in the Aerialite Range

AERIALITE LTD. STALYBRIDGE, CHESHIRE

DEPOTS AT:—
LONDON, BRISTOL, BIRMINGHAM, MANCHESTER NEWCASTLE, GLASGOW

DONCASTERS

FOR DROP FORGINGS IN LARGE OR SMALL QUANTITIES

DONCASTERS ◇ 1778 D D

DANIEL DONCASTER & SONS LIMITED · SHEFFIELD

FORGINGS · DROP FORGINGS · HARDENED STEEL ROLLS · HEAT TREATMENT

THE DARWINS GROUP

STANDARD CAR

DARWINS
SPECIAL STEELS *used in*

THE NEW
Standard Vanguard III

THE DARWINS GROUP
SHEFFIELD ENGLAND

D75

MEMO

BOLTS, NUTS, SCREWS,
WASHERS, RIVETS,
in Black, Bright, Non Ferrous
and Stainless Steel materials.

from SCREWS to
CEMENT MIXERS

It's so easy to stock through

Walkers

M. W. WALKER & STAFF LTD
ENGINEERS MERCHANTS
IBEX HOUSE, MINORIES, LONDON, E.C.3
'Phone: ROYal 8191 (10 lines) 'Grams: Makerlaw, Fen, London
Middle East Branch—Bahrain Persian Gulf

4th Edition of this essentially practical manual Now Ready

Diesel Maintenance: A Practical Guide to Servicing the Modern Automotive Diesel Engine

By T. H. Parkinson, M.I.Mech.E.
Edited by Donald H. Smith, M.I.Mech.E.

This well-known handbook is indispensable to all responsible for the maintenance and servicing of diesels of the automotive type; injection equipment in particular is dealt with in great detail. There is much on various aspects of fleet operation while the practical mechanic can obtain information from this book that he could scarcely acquire in several years of workshop practice. 8¼" × 5½" 216 pp. 123 illustrations.

12s. 6d. net. *By post 13s. 0d.*

Obtainable from booksellers or direct from:
ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD ST, LONDON, S.E.1

Quicker paint repairs with G.E.C.

INFRA-RED PAINT REPAIR UNITS

- all coats applied — and dried — in **one** day
- no blooming

Standard drying times for small patches

Primers and stoppers	10 minutes
Cellulose finishes	20 minutes
Synthetic finishes	30 minutes

Full details available on request.
The General Electric Co. Ltd., Magnet House, Kingsway, W.C.2.

Let R-I-L *mould* your future plans

Quality production of an established component, or the design and development of something quite novel—our plant and laboratories are fully organised to do either. Ultra-modern machines ensure accurate and well-finished products. Our technical staff will be delighted to discuss any requirements for mouldings or extrusions in rubber and plastics.

ANOTHER RIL PRODUCT

RUBBER IMPROVEMENT LIMITED
RILEX WORKS, WELLINGBOROUGH, NORTHANTS
Telephone Wellingborough 2218

"SHAKEPROOF"

REG. TRADE MARK Nos. 611535

LOCK WASHERS AND LOCKING TERMINALS

British Patents Nos. 404554 - 518146

with the tapered twisted teeth that lock tighter under vibration

Note the independent tooth form

Manufactured from high carbon spring steel, hardened and tempered, also available in phosphor bronze.

A.I.D. APPROVED

BARBER & COLMAN LTD

MARSLAND RD · BROOKLANDS · MANCHESTER

TELEPHONE: SALE 3277 (3 LINES)

TELEGRAMS: "BARCOL" SALE

"SHAKEPROOF" PRODUCTS

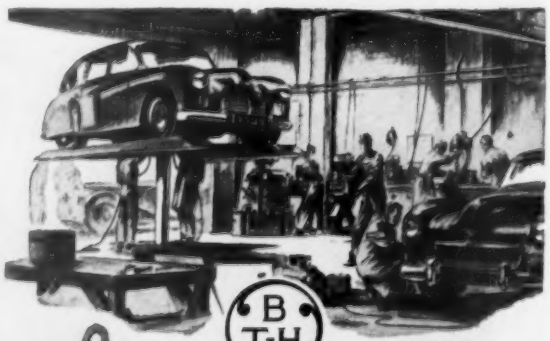
Factors' and Dealers' enquiries to:-
Wm. Clark (Spare Parts) Ltd., 438 Harrow Road, London, W.9.

S.B.1

There's gold in the sea . . . In a thousand million pints of sea-water there may be as many as 250 pints of gold. Now gold, by the pint, is lovely stuff. So why don't we all get after it? Well, you see . . . it's just a little bit difficult to extract.

In hundreds and hundreds of manufacturing processes, solvents are used—and wasted. They just float off into the air. Now solvents are expensive things, so why don't we pull them back again? Goodness knows . . . because, with Active Carbon, it's just too easy . . . **There's gold in the air!** for the man who reads about Active Carbon and Solvent Recovery, and telephones **SUTCLIFFE SPEAKMAN**

AND COMPANY LIMITED, LEIGH, LANCASHIRE. TEL: LEIGH 94.
LONDON OFFICE: 2 CAXTON ST., WESTMINSTER, S.W.1. TEL: ABBEY 3085



B T-H

ELECTRIC EQUIPMENT for Garage and Workshop

A.C. and D.C. Motors
Starters and control gear
Automatic pressure switches
Mazda lamps and lighting equipment

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED · RUGBY · ENGLAND

Member of the A.E.I group of companies

A6807

"It's FRY'S new" body solder

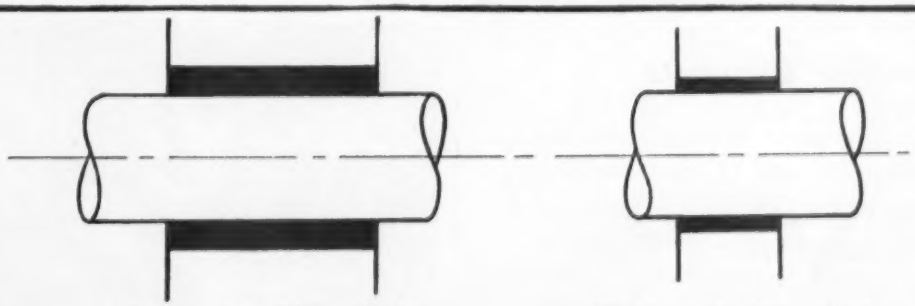
Many manufacturers use FRY'S new CARBODY solder for processes where economy is the prime consideration. CARBODY is quick and clean to use—and really cuts soldering costs. For the *finest* finish and where *quality* is important the established ABBEY and BELFRY Body Solders should be specified. Why not send today for samples of

FRY'S Body Solders

made by **Fry's Metal Foundries Ltd.**

TANDEM WORKS, MERTON ABBEY, S.W.19. Mitcham 4023
and at MANCHESTER · GLASGOW · BRISTOL · BIRMINGHAM & DUBLIN

41



Long and thick-walled Bushes are a waste of material.

Short and thin-walled Carobronze Bushes save material and are more efficient.

CAROBRONZE BRAND COLD-DRAWN PHOSPHOR BRONZE TUBING

possesses a high load capacity and excellent physical properties which enable Bearing Bushes to be made both shorter and thinner than is frequently the case.

As the machining allowances necessary with Carobronze are likewise very small

. . . . ***YOU SAVE IN EVERY DIRECTION***

CAROBRONZE LIMITED
School Road, Belmont Road,
London, W.4.

Phone: Chiswick 0245 *Grams: Carobronce-Chisk, London*

Swivelling Brackets

"Eclipse" Permanent Magnet Chucks, used in conjunction with "Eclipse" Swivelling Brackets, provide a tilting chuck having a full 90° angle of movement. Supplied in matched pairs to ensure complete accuracy and easily assembled with a magnetic chuck which can be modified with a minimum of trouble. Ask for Publication P.M. 140/54.

Supplies through appointed "Eclipse" Distributors

Eclipse

Magnetic devices designed to accelerate production

JAMES NEILL & CO. (SHEFFIELD) LTD., ENGLAND.

PM 13

MEN WHO KNOW . . .

The METALLURGIST who must have reliable and fully tested materials . . .

. . . and the ENGINEER who insists on accuracy and finish—

CHOOSE . . .

Carbon and alloy in all standard sections also supplied, fully heat treated, to engineering specifications.

KIRKSTALL

BRIGHT STEEL BARS

KIRKSTALL FORGE ENGINEERING LTD · LEEDS 5 . Telephone: HORSFORTH 2821

MI9

Collier's
TRADE MARK
WORM DRIVE
HOSE
CLIP
The Most Positive Worm Drive
The slots are pierced right through the band, thus affording the worm or screw an absolutely certain grip under all conditions.

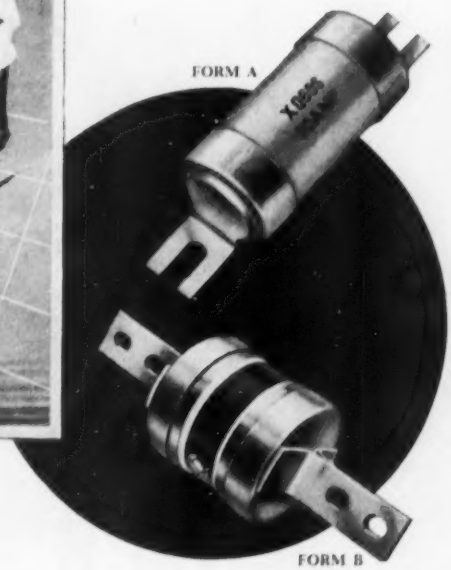
YI LTD

QUALITY CONTROL

at all stages of manufacture ensures a trouble free product . . . . the reason why most manufacturers use High Tensile Cylinder Head, Gear Box and other Studs made *by*

YARWOOD INGRAM & Co LTD
PARKER ST. BIRMINGHAM. 16.
TELEPHONE: EDGbaston 3607.

Do you know what's inside?



G.E.C. CARTRIDGE FUSE LINKS (H.R.C.)

The unique design combined with first-class workmanship and high quality materials are the reason for their outstanding performance.
More inside information on their construction and performance is contained in G.E.C. Switchgear Bulletin X2456 which will be sent to you on request.

Form A has offset fuse link contacts (tags).
Form B has central fuse link contacts (tags).

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

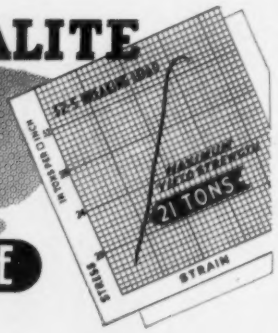
G.E.C.

LIGHT SERIES
These joints are designed specially for the aircraft industry and are of light alloy (Spec. L.40) anodised. Trunnion pins in hardened and ground steel, cadmium plated. They withstand some tension and compression loads and are available in a wide range of sizes.
HOOKE'S universal joints
for high speed dependability
Well suited to high speed drives these joints can be used where tension and compression loads occur and often eliminate the need for telescoping sleeves. They are made from 45-50 tons alloy steel to Air Board specification, with hardened steel trunnion blocks.
AIR MINISTRY GAUGE TEST HOUSE AUTHORITY 69755/21
THE MOLLART ENGINEERING CO LTD
KINGSTON BY-PASS SURBITON SURREY ENGLAND
PHONE: ELMBRIDGE 0033-7 GRAMS: PRECISION SURBITON

MANY ENGINEERS ALWAYS SPECIFY

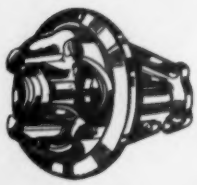
PERMALITE

the high tensile MALLEABLE



Mechanical properties:—

- ULTIMATE TENSILE STRENGTH 33/35 Tons per square inch.
- YIELD STRENGTH 20/22 Tons per square inch.
- ELONGATION 6% to 8%.
- BEND 90°.
- BRINELL VALUE 175.



Write for details

HALE & HALE (TIPTON) LIMITED DUDLEY PORT Staffs

The HEAVIER the duty the GREATER the need for

Don

SINTERED FRICTION MATERIALS

Unsurpassed for

* *Smoothness of operation*
* *Frictional stability*
* *Long operational life*

Enquiries to

SMALL & PARKES LTD

HENDHAM VALE WORKS, MANCHESTER 9
COLlyhurst 2311

LONDON OFFICE: 76 VICTORIA ST., SW1 VICtoria 1845/6

AUSTIN
USE
CLANCEY
CAST-IRON VALVE GUIDES
AND
CHILLED FACED TAPPETS
The AUSTIN A40 - A50 CAMBRIDGE
G·CLANCEY LTD · BELLE VALE · HALESOWEN
TELEPHONE: CRADLEY HEATH · 69411-2-3

The Symbol of Quality in Drop Forging
V
B
W
VAUGHAN BROS (DROP-FORGINGS) LTD.
EAGLE WORKS · WILLENHALL · STAFFS

Intal stands on its own good name

INTAL

THE INTERNATIONAL TWIST DRILL CO. LTD.

INTAL WORKS · WATERY ST. · SHEFFIELD · 3

Telephone : 23072-3 Telegrams : Fluted, Sheffield

OBTAINABLE FROM YOUR STOCKIST

London Stocks : 16, ALDERSGATE ST., E.C.1.

Phone: MON. 3505

Glasgow Stocks : 50, WELLINGTON ST., C.2.

Phone: CITy 6994

THE BUSH PEOPLE for NITRIDED JIG BUSHES and LINERS

NEW CATALOGUE AVAILABLE ON REQUEST

These jig bushes and liners are manufactured in accordance with B.S.S. 1098:1953, the recommended sizes for the jig plate holes being in accordance with British Standard for B limits (B.S.S. 164:1941).

Established 30 years

LAWRENCE Bros. MILLWARD LTD

WICKERSLEY

ROTHERHAM

P.V.C. WING PIPINGS, as supplied to leading motor manufacturers and body builders at home and abroad, have proved that plastic materials survive the severest tests. Whether as standard fittings used as wheel arch pipings or specially designed joint mouldings our sections are guaranteed to meet your particular requirements. Extrusions are our business — not just a department.

Please write for brochure on extrusions for the motor industry.

C. & C. MARSHALL LTD.

PLASTRIP HOUSE

OAKLEIGH ROAD NORTH, LONDON, N.20

Telephone: Hillside 5041 (3 lines) Cables: Tufflex, London

Telegrams: Tufflex, Norfinch, London

TUFFLEX

From
Silver Ghost to
SILVER CLOUD
ROLLS ROYCE LTD
have fitted
MARSTON RADIATOR MATRICES

MARSTON EXCELSIOR LIMITED
WOLVERHAMPTON & LEEDS
(A subsidiary company of Imperial Chemical Industries Ltd.)
MAR. 150

Silver Ghost

Silver Cloud

Chas. Clifford
Birmingham

'TELFOS' BRONZE — Chemical Composition, approx. 95% Copper, 5% Tin, ·02 - ·4% Phos; Tensile, 30 - 45 Tons per sq. in; Elongation, 15% - 20%; is a similar metal to Phosphor Bronze, yet possesses the remarkable advantage of machining three times as freely.
Write to us for a copy of our Descriptive Folder.

TELFOS BRONZE
REG. TRADE MARK
Free Machining Wrought Alloys

RODS AND BARS
Round, square, flat and hexagon.

saves labour...
speeds production...
cuts costs...

Charles Clifford Limited, Dog Pool Mills, Birmingham 30 *Offices: London Glasgow & Dublin*
M-W.132

DESIGNED FOR THE MOTORIST

'HERON'
Tappet Spanner Sets, incorporating the latest research in lightweight spanner design.

'WRYNECK'
A Half-Moon Ring Wrench designed to give access to certain obstructed nuts, such as exhaust manifold and starter nuts.

'WREN'
A shortened version of the well-known 'KESTREL' Ring Wrench.

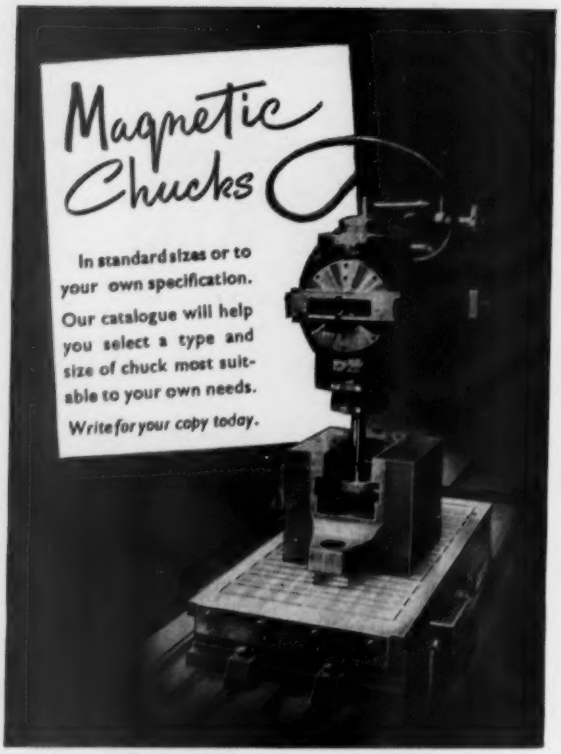
Obtainable from all recognised Tool and Motor Accessory Stockists.

Garringtons

A MEMBER OF THE GKN GROUP OF COMPANIES

GARRINGTONS LIMITED, BROMSGROVE, WORCS. ENG.

Magnetic Chucks



In standard sizes or to your own specification.

Our catalogue will help you select a type and size of chuck most suitable to your own needs.

Write for your copy today.

J. H. HUMPHREYS & SONS LTD.
Blackriding Electrical Works, Werneth, Oldham
'Phone: MAin 1651

MASON Bros.

Designers & Manufacturers of

PRESS TOOLS
JIGS & FIXTURES
GAUGES
MULTI-DRILLING HEADS

GENEVOISE JIG-BORING
PLASTIC MOULDS
KELLER DIE-SINKING

Designing & Drafting to the Trade

28, STATION RD, ACOCKS GREEN
BIRMINGHAM 27.

Telephone: Acocks Green 2969

Weathershields' 3-way Lift
HINGED ROOF-VENTILATOR
Specified by Britain's leading Coachbuilders

Easily adjustable to 3 positions; each unit supplied complete ready for painting and screwing into position; made to suit any size opening to recommended maximum of 3' 0" square. Available in plain Perspex or in a range of attractive colours.

Full technical data on request.

'Phone: MID: 5876
'Grams: "QUIPIT, B'ham"

Weathershields Ltd
BISHOP STREET, BIRMINGHAM, 5.

Casting Control . . .

The known behaviour of piston alloys under varying conditions is a prime consideration in casting. Correct cooling of the casting must take place if complete homogeneity and freedom from porosity is to be achieved. The Specialloid Hydraulic Die Casting Machines have been so designed that the cooling rate is controlled — coolant being applied both to core and die, resulting in unvarying quality of every piston.

For maximum performance, specify

Specialloid PISTONS

SPECIALLOID LTD., BLACK BULL STREET, LEEDS, 10 *Telephone: LEEDS 31471/7*

Scientifically developed—proved in application

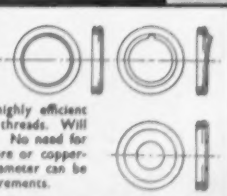
"LINERTITE" The perfect cylinder liner joint. Made from asbestos which is specially re-inforced with steel gauze. Heat and water resisting. Controlled thickness throughout for accurate bedding.

"CEMJO" Coopers steel and asbestos material for manifold gaskets. Edges burn to conform accurately with ports, but will not creep. Inexpensive yet highly efficient.

NEW AND MORE EFFICIENT JOINTS BY

SELF-CENTRING AND THREAD CLEARANCE WASHERS

In copper or aluminium. A highly efficient folded washer for conforming to threads. Will stand up to very high pressures. No need for hard tightening. Can replace fibre or copper-asbestos applications. Inside diameter can be varied to meet individual requirements.



COOPERS MECHANICAL JOINTS LTD.

PRESSINGS
TURNED PARTS
ASSEMBLIES

In ferrous or non-ferrous metals, electro or enamel finishes for the Automobile Industry and the General Engineering Trades.

Component parts or complete assemblies designed and produced to the customer's requirements.

Our technical staff will be pleased to advise.

W.H.BRISCOE & CO. LTD.

WHARFDALE ROAD, TYSELEY, BIRMINGHAM 11

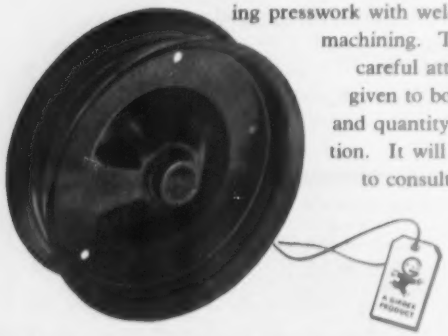
Telephone: ACOcks Green 1197
Telegrams: "Brisk, Birmingham."

Holdens

A COMPLETE SERVICE IN PRESSWORK AND WELDED ASSEMBLIES

GIRDEX

A complete, efficient service is offered in pressed parts and assemblies embodying presswork with welding and machining. The same careful attention is given to both batch and quantity production. It will pay you to consult Girdex.



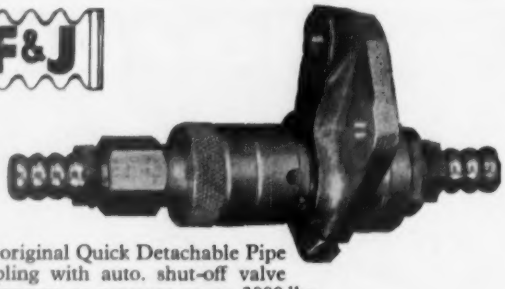
GIRDEX ENGINEERING COMPANY LIMITED

WESTON LANE, TYSELEY, BIRMINGHAM 11

Telephone: ACOcks Green 2205 Telegrams: GIRDEXPRES

GP 16

F&J



The original Quick Detachable Pipe Coupling with auto. shut-off valve for vacuum or pressure up to 3000 lbs.

FEENY & JOHNSON LTD.

WEMBLEY :: MIDDLESEX Phone: WEMbley 4801 & 4802

Get your free copies of the O-Ring Handbook and the Pioneer Catalogue — two publications prepared specially for engineers and designers.

When Oil seals must be 100% perfect

Specify PIONEER

Under the most rigid tests Pioneer Oil Seals have successfully sealed lubricants, chemicals and gases and have been completely effective against water, dirt or any foreign matter.

PIONEER OIL SEALS PLEASE

PIONEER OILSEALING & MOULDING COMPANY LTD.

A DIVISION OF J. H. FENNER & CO. LTD.

Factory and Head Office: Cottontree Works, Colne, Lancs. Telephone: Wycoller 411/2

Costs rising?

Today's all too familiar trend of increasing costs can only be halted by making production more economical. But how to do so raises problems too. Fortunately, when it comes to Malleable Iron Castings your interests are our particular concern.

The Blackheart Malleable Iron Castings we produce enable you to bring costs right down to earth. Production technique is such that castings are usually ready for immediate jig machining. Our castings conform to the Highest British Specification accepted—B.S.S. 310. (1947) Grade 3.

BLACKHEART *Malleable* IRON CASTINGS

SHOTTON BROS·LTD

OLDBURY, NEAR BIRMINGHAM

Telephone: BROadwell 1631-2

Photo by courtesy of the Austin Motor Co. Ltd.

PERMACEL BRINGS YOU

NEW DOUBLE DUTY masking tape

★ Permacel's new adhesive sticks better—instantly and firmly to any surface rough or smooth.

★ Clean line of demarcation. Permacel keeps all paint off protected areas.

★ Permacel sticks firmly and strips off cleanly, without affecting painted surfaces.

★ Permacel is unaffected by chemicals and solvents.

★ Permacel's extreme thinness prevents paint build-up at edges.

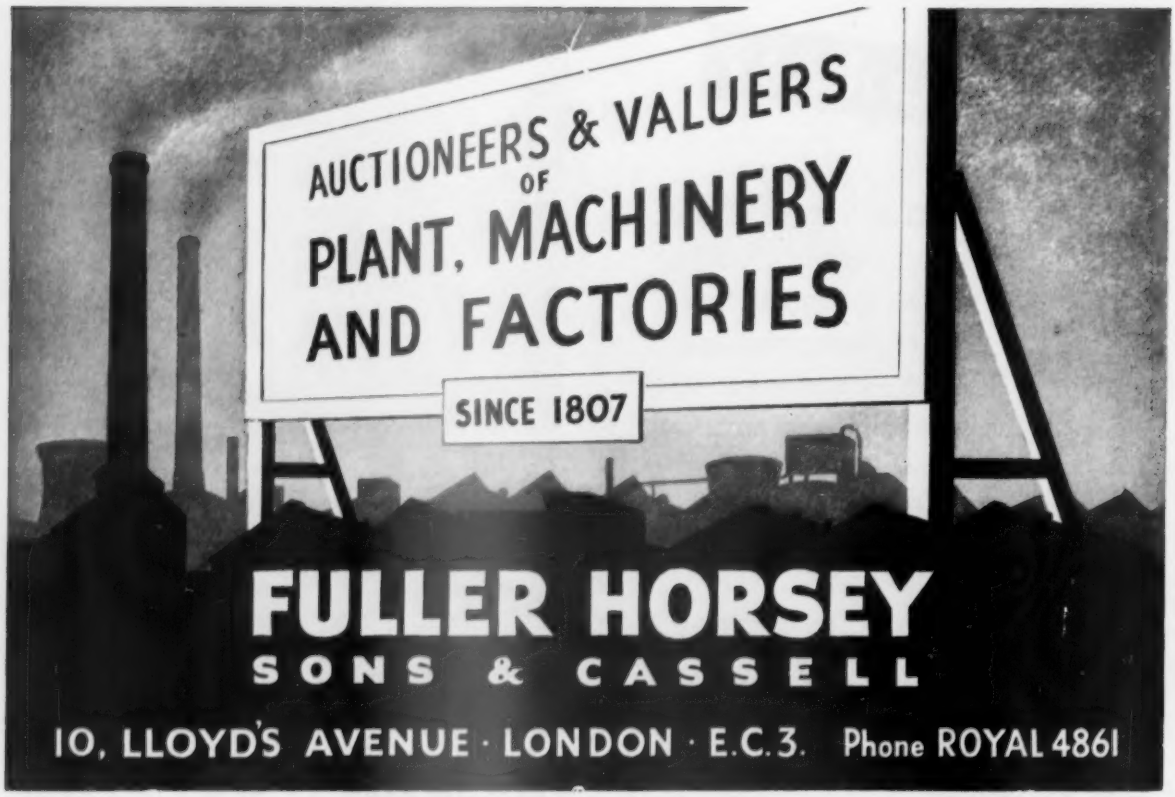
★ Permacel is skin flexible. Gets around awkward contours and uneven surfaces.

★ Write for your free copy of the Permacel Guide to over 400 uses for Permacel Self-Adhesive Tapes to Dept. A.E., Industrial Division.

PERMACEL TRADE MARK

SELF-ADHESIVE TAPES

Johnson & Johnson (GT. BRITAIN) LTD., SLOUGH, BUCKS.



Rathbone

FOR ALL ENGINE PARTS

Nitrided Nitralloy Steels for all engine parts which are subject to frictional wear. Also for Gauges and Jigs. Where there's rub, there's Nitrided Nitralloy.

NITRIDED *Nitralloy* NN STEELS

NITRALLOY LTD., ATLAS WORKS, SHEFFIELD, 4

Telephone : 26646 Sheffield *Telegrams* : Nitralloy, Sheffield.

THE MODERN DIESEL

By Donald H. Smith, M.I.MECH.E. 12th Edition.

The latest edition of this standard handbook has been mainly rewritten and enlarged to include reviews of nearly all automotive-type diesels in current use in Britain, U.S.A., the Dominions and on the Continent. Engines for road, railway and marine service, for tractor and for many industrial purposes are discussed. In addition, chapters dealing with the theoretical and practical aspects of the diesel as a power unit are included.

8½"×5½". 254*pp.* 210 *illustrations.* **12s. 6d.** *net. By post* **13s. 0d.**

Obtainable from all booksellers or direct from:
The Publishing Dept., Iliffe & Sons Ltd.,
Dorset House, Stamford St., London, S.E.1

ASSOCIATED ILIFFE TECHNICAL BOOKS

WE HAVE THE LARGEST FLEET OF

Fork-lift Trucks for hire

IN THE COUNTRY . . . and we are the largest manufacturers of wood pallets, too!

Youngman

W. C YOUNGMAN LIMITED, WANDSWORTH WORKS, WANDSWORTH ROAD, LONDON, S. W. 8. **TELEPHONE: MACAULAY 2233 (6 LINES)**

wiring and cable clips . . .

to snap into sheet metal as supplied to leading Automobile Manufacturers. One class of many Fastening devices manufactured by 'Dot'.

TRADE DOT MARK

CARR FASTENER CO. LTD.

Stapleford, Nottingham. Telephone: Sandiacre 3085
London: 47 Woburn Place, W.C.1 Museum 1433
Manchester: 50 Newton St., Manchester, 1 Central 4057

Next time you fit a

SHOCK ABSORBER-

insist on

NEWTON TRADE PRODUCT MARK REGISTERED

Hydraulic

SUSPENSION CONTROL UNIT

Standard Equipment on most British Commercial passenger-carrying vehicles

Manufactured under one or more of the following Patents
9017/54, 19978/53
688286, 629727
627170, 460851

★ **Send for illustrated Catalogue No. 226-1/1**

NEWTON & BENNETT LTD. VALETTA RD. LONDON W.3
Telephone Shepherds Bush 3443/6

AUTOMOBILE ENGINEER

CLASSIFIED ADVERTISEMENTS

RATE 4d. PER WORD. MINIMUM 4/-

Each paragraph charged separately. Box number 5 words plus 1/-. Advertisements for the 1955 Show Review No. should be to hand not later than first post 9th November

(No responsibility accepted for errors).

BALL BEARINGS

BALL and Roller Bearings. All types and sizes. Largest stocks; lowest prices. Same day despatch. Claude Rye Bearings, 895-921, Fulham Road, London, S.W.6. Renown 6174 (Ext. 24). [4964

BUSINESS & PROPERTY

MAIN road position. Close Bedford. Petrol Station and Garage. Petrol sales exceed 80,000 gallons. Turnover £60,000. Substantial Showrooms, Garage and House. All details:—R. W. Stonebanks & Co., Estate Agents, 261 Bedford Road, Kempston, Beds. Tel. No. 3361/2, and 17 St. John's Street, Bedford. Tel. No. 67744/5. [5090

GARAGES FOR SALE

FREEHOLD Garage for sale, Church End, Finchley, N.3. Attractive Offices and Flat. Substantial Ground Floor Garage. Concreted Yard and Forecourt. Area 6,400 sq. ft. Freehold £13,500.

SOLE Agents: Chamberlain & Willows, 23 Moorgate, E.C.2 (Met 8001). [5097

PATENTS

THE Proprietor of British Patent No. 719486, being a brake for private and commercial vehicles, entitled "Concentric Cam," offers same for licence or outright sale, to ensure the practical working of same in Great Britain. Enquire, Re-lined Brake Drums Ltd., 76 Stoke Newington High Street, N.16. [5037

THE Proprietor of British Patent No. 578633, entitled "Improvements in Articulated Road Vehicles," offers same for licence or otherwise to ensure practical working in Great Britain. Enquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago, Illinois, U.S.A. [5083

MACHINERY FOR SALE

TWO Magee No. 10 Automatic Wiring and Edging Machines for sale. Capacity, minimum, 24 s.w.g. sheet and 10 s.w.g. wire; maximum, 14 s.w.g. sheet and ¼ in. wire, or 16 s.w.g. sheet and 5/16 in. wire. Two rates of feed, 6 and 18 ft. per min. Treadle clutch. Motor drive for 400/3/50. Photo, F. J. Edwards Ltd., 359 Euston Road, London, N.W.1. [5087

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

TRANSPORT Engineer required (London), fully qualified to control maintenance and repairs of fleet of commercial vehicles and cars. Apply in writing, stating age, experience, qualifications and salary required, to Box 7137, c/o Automobile Engineer. [5086

FORD Motor Company Limited, of Dagenham, Essex, have vacancies for lecturing appointments in engineering subject as follows:—

(a) A lecturer whose main duties would be concerned with automobile engineering subjects. He should be capable of supervising practical work in a well equipped automobile engineering laboratory and it would be an additional recommendation, but not essential, if he were capable of undertaking tutorial work for a range of subjects of his own choice in the National Certificate Mechanical Engineering course up to A.1 level.

(b) A lecturer capable of teaching engineering drawing at all levels, including City and Guilds and National Certificate courses, together with selected subsidiary subjects to S.3 level.

CANDIDATES should possess a suitable qualification, not less than Higher National Certificate, and practical engineering experience is essential. Salary will be at a rate not less than Burnham lectureship grade, whilst subsequent annual salary increases depend upon proven merits. Superannuation is generous and non-contributory.

REPLIES requesting an application need be only briefly worded, but they should include an indication of the main and subsidiary subjects offered. Applications should be addressed to Salaried Personnel Department, quoting reference LMH/2. [5088

SITUATIONS VACANT

AUTOMOBILE Project Engineering.

WHERE goes automotive development? It might depend on you! We have plenty of revolutionary ideas, but we want more engineers to help speed design projects.

TECHNICAL standard—H.N.C. Automobile experience—thoroughly sound. Character—determined. Could this apply to you? If so, you are in line for an attractive starting salary, a good job, and a generous non-contributory pension. Salaried Personnel Department, Ford Motor Company Limited, Dagenham, Essex, will be glad to hear from you. Please quote reference VPE/4. [5091

YOUNG Engineer required for Research and Development of Engine Governors and other forms of control mechanisms. Degree or H.N.C. level and some knowledge of servo mechanics required. Age 23-30. Starting salary up to £750, according to qualifications and experience. The post offers considerable opportunities in a relatively new and growing branch of engineering. Apply to Personnel Manager, Davey, Paxman & Co. Limited, Colchester. [5093

FORD Motor Co. Ltd., of Dagenham, Essex, have a vacancy for a Technical Report Writer at their Tractor Field Test Station. He should have a sound practical background and at least Ordinary National Certificate. There will be plenty of scope for a man of intelligent ideas—does this mean you?

FROM pay to pension, Ford is in the first flight. Our Salaried Personnel Department would like to hear from you. Please quote reference VTR. [5094

CITY of Birmingham Education Committee.

ASTON Technical College, Whitehead Road, Birmingham, 6.

PRINCIPAL: D. Dudgeon Stockley, B.Sc., M.I.Mech.E., F.I.I.A.

FOLLOWING internal promotions, applications are invited for the undermentioned vacancies in the Mechanical Engineering Department:—

ASSISTANT, Grade B, to teach up to Ordinary National Certificate standard in Applied Mechanics and Heat Engines or Workshop Technology, and general subjects of City & Guilds Machine Shop Engineering and Motor Vehicle Mechanics' Work courses. Candidates should possess a Degree or Higher National Certificate in Mechanical Engineering and should have had industrial and, preferably, teaching experience. Knowledge of automobile engineering would be an added qualification. Salary according to Burnham (Further Education) Scale for Assistant, Grade B, £525 × £25—£820. Additional training and graduate allowance where applicable.

ASSISTANT, Grade A, to teach general Mechanical Engineering subjects associated with Ordinary National Certificate and with City & Guilds Machine Shop Engineering and Motor Vehicle Mechanics' Work courses. Applicants should possess appropriate qualifications and should have had industrial and, preferably, some teaching experience. Salary according to Burnham (Further Education) Scale for Assistant, Grade A, £450 × £18 — £725. Additional training and graduate allowance where applicable.

FURTHER particulars and application form may be obtained from the Principal, to whom applications should be returned within 14 days of the appearance of this advertisement.

E. L. Russell,

CHIEF Education Officer. [5095

SALES Engineer required for Truck Manufacturing Organization in South Midlands. Higher National Certificate in Mechanical Engineering essential and corporate membership of one of the major institutions desirable.

APPLICANTS should have practical and design experience in Automobile Engineering. This position offers excellent prospects for the right man.

WRITE, giving details of experience, age and salary required, to Box EA1896, A.K. Advertising, 212A Shaftesbury Avenue, London, W.C.2. [5079

THE Rootes Group Truck Plant, in the process of an extensive expansion programme, invites applications from all grades of Draughtsmen to join their design team on a wide variety of chassis and body work. Excellent working conditions with an attractive salary scale, together with Welfare and Staff Pension Scheme facilities.

PLEASE apply in writing to the Secretarial Department, Commer Cars Limited, Luton. [5089

SITUATIONS VACANT

ARMSTRONG Siddeley Motors require the services of Motor Car Chassis and Body Draughtsmen for work in Coventry. Experience on design layouts and detailing is required, and a good salary and prospects offered. All replies will be treated in confidence and should state age, experience, qualifications and salary required, to Personnel Manager, Armstrong Siddeley Motors, Coventry, quoting Reference MCC. [5096

HARRY FERGUSON RESEARCH LTD. require Automobile Design Draughtsmen, preferably with H.N.C. or equivalent. Interesting work on new projects, with excellent prospects. Non-contributory superannuation scheme. This Company is at present temporarily located near Banbury, pending the erection of new premises near Coventry. Free transport available daily to and from temporary premises and Coventry.

APPLY in writing to Chief Draughtsman, Harry Ferguson Research Ltd., Chipping Warden Aerodrome, Nr. Banbury, Oxon. [5078

SITUATIONS WANTED

CAMBRIDGE Graduate, early thirties, qualified engineer, also degree economics, 15 years' experience various aspects motor industry (emphasis design, development, material and production control) seeks scope for systematic imaginative mind. Box 7258, c/o Automobile Engineer. [5098

BOOKS WANTED

WANTED, 1 copy of each of the following issues of the "Automobile Engineer":—**1948**—Volume 38: January, February, March, May, June, July, August. 1949—Volume 39: March, April, September, October, November Extra Copy. 1950—Volume 40: January. 1951—Volume 41: June, August, September. 1952—Volume 42: August. 1953—Volume 43: April. 1954—Volume 44: January. Box 7136, c/o Automobile Engineer. [5092

BOOKS

RESISTANCE Welding in Mass Production. By A. J. Hipperson, B.Sc.(Eng.), A.M.Inst.W., and T. Watson, M.Inst.W. The ground covered by this book ranges from the first principles of each process to its scientific application in mass production. Particular reference is made to design and production requirements. 21s. net from all booksellers, 21s. 7d. by post from The Publishing Dept., Dorset House, Stamford Street, London, S.E.1.

STEELS in Modern Industry: A Comprehensive Survey by 29 Specialist Contributors. General Editor W. E. Benbow. An invaluable guide for engineers, designers and draughtsmen; it specifies the steels best used in various engineering applications (bearing in mind the present need for economy), describes their general and special properties and characteristics, and how they may be surface finished for anti-corrosive and other purposes. 42s. net, from all booksellers. By post 43s. 3d. from The Publishing Dept., Dorset House, Stamford Street, London, S.E.1.

AUTOMOBILE Efficiency: Maintaining Performance with Electrical Test Equipment. By E. T. Lawson Helme, A.M.A.E.T., A.M.I.M.I. Intended for managers and operatives in the smaller service stations, this handbook describes the establishment of a modern engine tuning and maintenance department, supported by comprehensive electrical service. The various tests for tracing causes of poor performance, fault-finding in all parts of vehicle electrical equipment, a recommended system of electrical workshop practice, organization of a battery-charging service, and such matters as publicity methods, charges, operating an economical schedule of work, etc., are all covered in detail. 10s. 6d. net from all booksellers. 10s. 11d. by post from The Publishing Dept., Dorset House, Stamford St., London, S.E.1.

GAS Welding and Cutting: A Practical Guide to the Best Techniques. By C. G. Bainbridge, M.I.Mech.E., M.Inst.W. A comprehensive textbook providing practical information on almost the whole range of available gas welding and cutting equipment, methods and processes. Invaluable to the practical welder as well as to those responsible for gas welding and cutting operations involved in the fabrication and repair of industrial equipment. Price 15s. net. By post 15s. 6d. From all booksellers or from The Publishing Dept., Dorset House, Stamford Street, London, S.E.1.

★ **Are you an Electrical Engineer?**

★ **Are you used to modern motor vehicle circuits?**

★ **Do you want a really unusual job?**

If so, you must be prepared for the unusual and the hard work that goes with it. We are a motor manufacturing company of the highest international repute. We want a man of at least H.N.C. standard with inspection experience which can be transformed into something more useful—the ability to make a positive contribution to continuous improvement in the quality of our products. In short, a Quality Control Engineer.

This is an excellent opening for a live, intelligent young man who is not afraid of occasionally getting his hands dirty. His salary will improve with his performance and a generous non-contributory pension will be his on retirement.

Are you the man? Then you owe it to yourself to act. Reply to Box No. 6672, quoting reference QCA/E.

In the BAR they are saying

PRECISION PARTS *from the* BAR *by* M C L

Made to customer's specification in any quantity.

For precision parts from the bar in any metal, particularly those which are not produced by the cold head or roll threaded process . . . consult the specialist machinists.

M.C.L. & REPETITION LTD.

POOL LANE · LANGLEY · BIRMINGHAM

Telephone: Broadwell 1115 (4 lines) and 1757

Quality Control—a combination of engineering and statistical techniques which can improve even the best of products.

Is this your definition?

If so, you agree with us—and we are motor vehicle manufacturers of the highest international repute, both as engineers and employers. Our aim is unending improvement, which creates opportunities for additional Quality Control Engineers. Inspection experience, particularly in the motor industry, will stand you in good stead, but with a dynamic difference in approach. You must be ready to point the way to better things and not merely say yea or nay to other men's work.

In short, we want you to be of at least H.N.C. standard with a mathematical flair, not afraid to get your hands dirty if problems can best be solved that way. For the right applicants it means first class security with a free pension and a salary which improves with their performance. Do you think you could make one of them? If so, you owe it to yourself to apply to Box No. 6673. Please quote reference QCA/M.

★★★★★★ **SIX STAR**

Sellotape BRAND

THE NEW IMPROVED MASKING TAPE

GORDON & GOTCH LTD. SELLOTAPE DIVISION
39-40 FARRINGDON ST. LONDON, E.C.4

SWISS JEWELLED LEVER

STOP WATCHES

ALL ARE FULLY GUARANTEED

Whatever use you have for a "Timer" use a PRESTONS STOP-WATCH. They are all top-quality Swiss precision instruments.

Send for our Price List, "Swiss Timers in Industry"

PRESTONS LTD. TEL. BOLTON 870-877

BOLTON (EST. 1869) LANCS.

EXTRUSIONS BY MARLEY

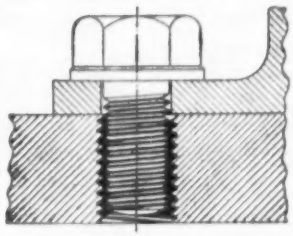
Buyers requiring rigid and flexible tubes and sections in thermoplastic materials should ask for a quotation from

MARLEY EXTRUSIONS LTD.

Dept. 131, Lenham, Maidstone, Kent.

Telephone: Harrietsham 381.

WIRE THREAD INSERTS



FOR NEW DESIGNS AND SALVAGE

CROSS MFG. CO. (1938) LTD.

COMBE DOWN · BATH

Tel.: COMBE DOWN 2355/6

MEK-ELEK Engineering Ltd

17, Western Road, Mitcham, Surrey.

COTTON BAGS

FOR SPARE PARTS Etc.

Walter H. Feltham & Son Ltd

Imperial Works, Tower Bridge Road

Telephone: HOP 1784. LONDON, S.E.1

Anderton

Cyril Circlip's Stock ranges from 1/16" to 10"

Write for **DATA SHEETS** *to Dept. A.1*

ANDERTON SPRINGS LTD · BINGLEY

Phone: Bingley 2226 & 2351

Grams: Circlips Bingley

CIRCLIPS

To help your design department: The Lewis Spring Co. offer a 40-page booklet on spring design, full of technical data. 2/6 post free.

THE LEWIS SPRING CO. LTD.
RESILIENT WORKS, REDDITCH.
'Phone Redditch 720/1/2.

LONDON OFFICE: 321, High Holborn, W.C.1.
'Phone Holborn 7479 & 7470.

Nickel plated spring steel clips from ¼" to 1½" (1½" size—17/6 gross net), tool clips in the same material and sizes, phosphor bronze clips from 9 mm to 22 mm —say when! There are lots of variations on the same theme and if it isn't in stock we can soon make it. Better get in touch with Lewis of Redditch today.

LEAVE IT TO **Lewis** OF REDDITCH
SPRINGS, SPRING CLIPS
PRESSWORK, WIRE FORMS
VOLUTE SPRINGS

INDEX TO ADVERTISEMENTS

	PAGE
Abingdon King Dick Ltd.	82
AC-Delco Division of General Motors Ltd.	36
Adamant Engineering Co. Ltd.	71
Aerialite Ltd.	104
Aluminium Bronze Co. Ltd.	88
Amal Ltd.	98
Anderton Springs Ltd.	123
Angus, George, & Co. Ltd.	75
Archdale, James, & Co. Ltd.	4
Armstrong Whitworth & Co. (Pneumatic Tools) Ltd.	55
"Automobile Chassis Design"	80
Automotive Engineering Ltd.	101
Automotive Products Co. Ltd.	5, 6, 7, 8
Bakelite Ltd.	40
Barber & Colman Ltd.	108
Benton & Stone Ltd.	89
Berry, Henry, & Co. Ltd.	85
Birkett, T. M., Billington & Newton Ltd.	50
Birlec Ltd.	3, 20, 73
Birmetals Ltd.	87
Birmingham Aluminium Casting (1903) Co. Ltd.	Cover iv
Black & Decker Ltd.	53
Box No. 6672	123
Box No. 6673	123
B.P. Petrol	91
Briscoe, W. H., & Co. Ltd.	118
British Belting & Asbestos Ltd	Cover ii
British Electrical Development Association	32
British Geon Ltd.	83
British Oxygen Co. Ltd., The	56
British Piston Ring Co. Ltd., The	65
British Thomson-Houston Co. Ltd.	108
Brown, David, Corporation (Sales) Ltd., The	41, 67
B.S.A. Tools Ltd.	62
Burton Griffiths & Co. Ltd.	62
Bushing Co. Ltd., The	39
Cape Asbestos Co. Ltd., The	16, 17
Carobronze Ltd.	109
Carr Fastener Co. Ltd.	121
C.A.V. Ltd.	35
Cincinnati Milling Machines Ltd.	46, 47
Clancey, G., Ltd.	113
Clayton Dewandre Co. Ltd.	38
Clifford Coverings Co. Ltd.	115
Climax Molybdenum Co. of Europe Ltd.	48
Cohen, Geo., Sons & Co. Ltd.	82
Cole, E. K., Ltd.	104
Collier & Collier Ltd.	110
Concentric Manufacturing Co. Ltd.	78
Cooper & Co. (Birmingham) Ltd.	86
Coopers Mechanical Joints Ltd.	117
Copper Development Association	84
Cross Mfg. Co. (1938) Ltd.	123
Darwins Ltd.	106
Desoutter Bros. Ltd.	29
"Diesel Maintenance"	106
Dobbie, McInnes Ltd.	100
Doncaster, Daniel, & Sons Ltd.	105
Drummond-Asquith (Sales) Ltd.	9
Eagle Pencil Co.	102
Eaton Axles Ltd.	13
Elgar Machine Tool Co. Ltd.	98
Feeny & Johnson Ltd.	118
Fel Electric Ltd.	102
Feltham, Walter H., & Sons Ltd.	123
Ferodo Ltd.	37
Firth-Derihon Stampings Ltd., The	24
Fletcher Miller Ltd.	94
Fry's Metal Foundries Ltd.	109
Fuller, Horsey, Sons & Cassell	120
Funditor Ltd.	86
Garringtons Ltd.	116
General Electric Co. Ltd., The	107, 111
Girdex Engineering Co. Ltd.	118
Girling Ltd.	58
Glacier Metal Co. Ltd., The	81
Gordon & Gotch Ltd.	123
Guest, Keen & Nettlefolds (Midlands) Ltd.	80
G.W.B. Furnaces Ltd.	93
Hale & Hale (Tipton) Ltd.	112
Hardy Spicer & Co. Ltd.	10
Harper, John, & Co. Ltd.	43
Heenan & Froude Ltd.	22
Hey Engineering Co. Ltd.	96
Hoffmann Manufacturing Co. Ltd., The	63
Holroyd, John, & Co. Ltd.	51
Hoyt Metal Co of Great Britain Ltd., The	100
Humphreys, J. H., & Sons	116
I.C.I. (General Chemicals, Heat Treatment) Ltd.	18
I.C.I. (Marston Excelsior) Ltd.	115
I.C.I. (Metals) Ltd.	95
Imperial Smelting Corporation	Cover iii
International Twist Drill Co. Ltd., The	114
Jackson, H., Ltd.	25
Jessop, Wm., & Sons Ltd.	60
Johnson & Johnson (Great Britain) Ltd	119
Kemson Engineering Co. Ltd.	84
Kirkstall Forge Eng. Ltd.	31, 110
Lawrence Bros. Millward Ltd.	114
Laycock Engineering Co. Ltd.	45
Laystall Engineering Co. Ltd.	97
Lee, Arthur, & Sons Ltd.	64
Lewis Spring Co. Ltd., The	124
Linread Ltd.	52
Long Meadow Felt Co., The	11
Marley Extrusions Ltd.	123
Marshall, C. & C., Ltd.	114
Mason Bros.	116
M.C.L. & Repetition Ltd.	123
Mek-Elek Engineering Ltd.	123
Metalastik Ltd.	26, 27
Midland Motor Cylinder Co. Ltd., The	Cover i
'Modern Diesel, The"	120
Mollart Engineering Co. Ltd.	112
Monochrome Ltd.	78
Morane Plastic Co. Ltd., The	100
Morgan Crucible Co. Ltd., The	34
Moss Gear Co. Ltd.	103
Neill, Jas., & Co. (Sheffield) Ltd.	110
Newall, A. P., & Co. Ltd.	99
Newton & Bennett Ltd.	121
Nitralloy Ltd.	120
Park Gate Iron & Steel Co. Ltd., The	74
Perry Barr Metal Co. Ltd.	68
Pioneer Oilsealing & Moulding Co. Ltd.	118
Pollard Bearings Ltd.	19
Prestons Ltd.	123
Quasi-Arc Ltd.	15, 59
Ransome & Marles Bearing Co. Ltd.	57
Redifon Ltd.	79
Renfrew Foundries Ltd.	28
Renold Chains Ltd.	23
Richards, Chas., & Sons Ltd.	104
R.J.H. Tool & Equipment Co. Ltd.	42
Royal Sovereign Pencil Co. Ltd., The	98
Rubber Bonders Ltd.	70
Rubber Improvement Ltd.	107
S. & D. Rivet Co.	102
Salter, George, & Co. Ltd.	2
Sandwell Casting Co., The	90
"Servicing Guide to British Motor Vehicles"	92
Sheffield Twist Drill & Steel Co. Ltd., The	69
Sherborne Rubber Co. Ltd., The	92
Shotton Bros. Ltd.	119
Silentbloc Ltd.	54
Simmonds Aerocessories Ltd.	72
Skefko Ball Bearing Co. Ltd.	76
Small & Parkes Ltd.	14, 112
Specialloid Ltd.	117
Spencer, H. F., & Co. Ltd.	33
Super Oil Seals & Gaskets Ltd.	30
Sutcliffe, Speakman & Co. Ltd.	108
Tecalemit Ltd.	77
Terry, Herbert, & Sons Ltd.	12
Toledo Woodhead Springs Ltd.	66
Tucker, George, Eyelet Co. Ltd.	94
Udal, J. P., Ltd.	90
Unbrako Socket Screw Co. Ltd.	44
Vaughan Bros. (Drop Forgings) Ltd.	113
Walker, M. W., & Staff Ltd.	106
Ward, T. W., Ltd.	96
Weathershields Ltd.	116
Wellworthy Piston Rings Ltd.	88
Weston, Chas., & Co. Ltd.	61
Wickman Ltd.	1, 49
Yarwood, Ingram & Co. Ltd.	111
Youngman, W. C., Ltd.	120
Zinc Alloy Die Casters' Association	21

Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by James Cond Ltd., Charlotte Street, Birmingham 3. "Automobile Engineer" can be obtained abroad from the following: AUSTRALIA & NEW ZEALAND: Gordon & Gotch Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service Ltd.; Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency Ltd.; Wm. Dawson & Sons (S.A.) Ltd. UNITED STATES: The International News Co. Entered as Second Class Matter at the New York, U.S.A., Post Offices.

"Nash Metropolitan" with MAZAK die cast grille

Planning for Production. . .

The choice of die casting for individual body fittings, such as the grille, widens enormously the scope of attractive styling and permits the streamlining of much incidental fabrication.

Die castings of unit construction, strong and easily handled, designed for simple and rapid assembly, reduce fitting operations to a minimum.

For economy, maximum strength and flawless finish, the die castings should be in MAZAK.

MAZAK FOR PRODUCTION IN DIE CASTINGS

IMPERIAL SMELTING

U.K. MEMBER OF THE CONSOLIDATED ZINC CORPORATION LIMITED

IMPERIAL SMELTING CORPORATION (SALES) LIMITED, 37 DOVER STREET, LONDON, W.1.

For over half a century Birmal have been

supplying aluminium and magnesium light alloy castings

in the sand, gravity die and pressure die process.

Our reputation is built on solid foundations,

skill . . . quality and craftsmanship.

Our specialist experience in the art of producing

intricate castings of all types

enables us to offer a service that carries on

where most others end.

YOU GET MORE THAN A CASTING FROM

Birmingham Aluminium Casting (1903) Company Limited
Birmid Works · Smethwick · Birmingham 40